Vol. 19 DECEMBER 1946 No. 12

Instruments

THE MAGAZINE OF Measurement and Control

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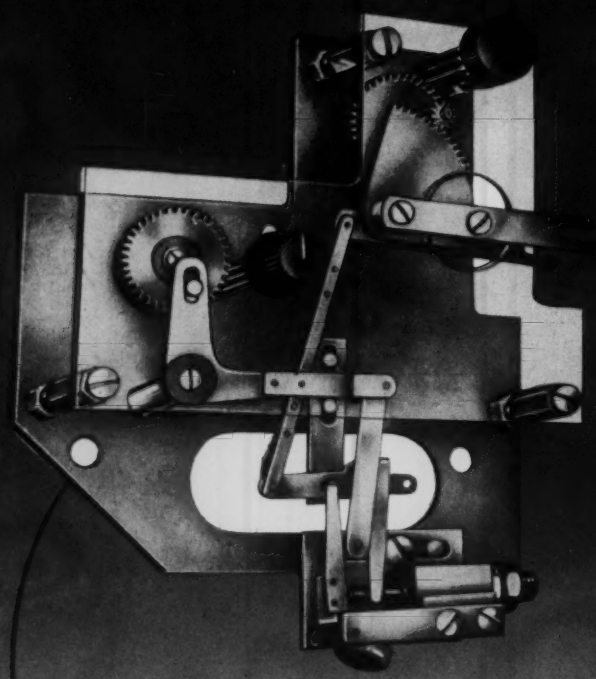

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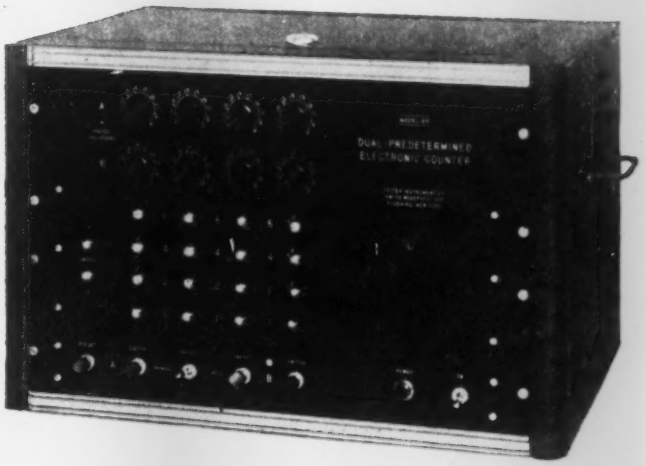

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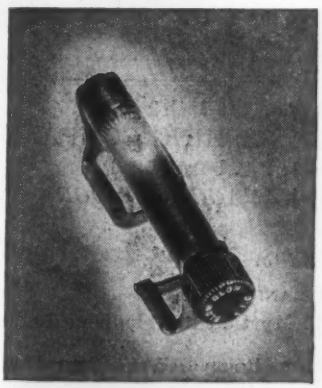

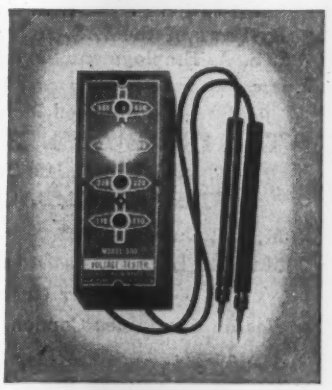

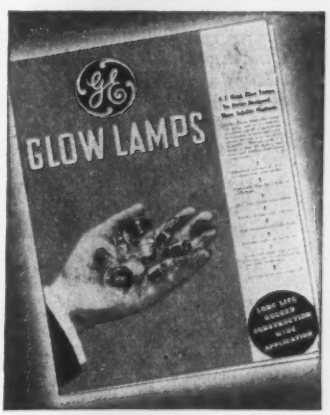

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Instruments
THE MAGAZINE OF
Measurement and Control

Vol. 19 December 1946 No. 12

COVER: Glimpse through windows of Gulf Oil research laboratories showing part of a battery of engines for determining octane number.

(Courtesy Gulf Oil Corporation)

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Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

Slogan for 1947: The End Must Determine the Means

ONE of the reasons for which 1946 will be pleasantly remembered by Instrument Men is that during this first full calendar year of peace, a record-breaking number of disclosures* was made—disclosures of war-developed methods of detection, of measurement, of transmission, of testing, of automatized inspection and of automatic control, most of them having far greater peace-time possibilities than military applications.

This is not the occasion for presenting a complete catalog of these disclosures. The most important ones have already been publicized in this magazine. Our purpose, rather, is to report a significant effect which these disclosures are having upon the Instrument Man in general—and upon the *experienced* Instrument Man in particular.

The typical Instrument Man we have in mind may have been one of the four thousand who attended the conference in Pittsburgh or, if unable to come, eagerly read the 16-page Program Supplement in our September issue containing abstracts of the technical papers and is eagerly reading the full texts of these papers, which we have been printing since August.

The typical experienced Instrument Man is more than a chart boy and less than a company president. His title may not include the word "instrument." He may work in a manufacturing plant, in one of the communications industries, in a laboratory, in a transportation industry....He is you, and you, and you...

The typical Instrument Man now knows for certain what he had surmised, that there are innumerable practical solutions for his measurement and control problems and that many of these solutions are commercially available.

But this knowledge is not the significant effect we wish to report, although it is one of its causative factors. The effect is what might be termed the transition from the stage of awe-struck fascination by new methods to the stage of cool calm acceptance of the rich diversity of methods, plus wise discrimination in choices.

No longer do we find the typical Instrument Man so fascinated by one category of physical phenomena that he closes his ears to the enthusiastic exponents of other categories. Today, an Instrument Man who is infatuated with (or blindly opposed to) any single class of devices is the exception.† And it's a good thing for the advance of technology that the typical Instrument Man has no prejudices for or against any group of methods of measurement and of automatic control!

Perhaps this new frame of mind can be epitomized in the slogan "The End Must Determine the Means."

Instrument men have a well-developed cause-and-effect sense. They know that the argument that "the end justifies the means" (for example when a teen-age deliquent is sent to a so-called "reform" school) is false because *the means determines the end* (the child becomes a criminal). They know that if the end is to measure the temperature of molten steel the means can't be a glass thermometer!

The great significance of this attitude is twofold: First, it stimulates research and accelerates practical developments on the part of *all* manufacturers of devices for measurement, inspection, testing and automatic control. Second, it minimizes the remaining shortcomings of practical applications and maximizes the benefits—not only the immediate benefits to instrument users but the ultimate benefits to the American people: better goods, better transportation and communication services, higher living standards without higher living costs. —MFB

*Sensational disclosures were made during August-December 1945, but those of greatest immediate industrial applicability were made during 1946.

†Perhaps it would be more accurate to say that these exceptions are not permanently prejudiced for or against certain classes of devices, but hold these prejudices during long or short periods in their careers—generally "short" rather than "long" periods. A case in point is the discussion that has been let loose by the article on Oak Ridge in the August *Fortune*, implying that the "eleven miles of control boards...topping 200,000 instruments... about 40,000 actual control instruments" included only air-operated controllers and did not include any electronic instruments at all. We know some electronic enthusiasts who, after participating in discussions about that article, decided to look into the possibilities of fluid relays—hydraulic as well as pneumatic. BUT we know also some anti-electronics men who heard the advantages of electron tubes expounded so eloquently during these same discussions that *their* prejudices vanished.

The Counter Reads 0 0 2 2 8

and thereby registers the end of the nineteenth year of *Instruments'* service to users of measurement and control devices—service to the UNITED STATES OF AMERICA

The entire staff of *Instruments* wishes you

A Merry Christmas and a Happy New Year

Use of Instruments in Quality Control Work *

By JOSEPH MANUELE, Director of Quality Control, Westinghouse Electric Corp., East Pittsburgh, Pa.

ELI WHITNEY, inventor of the cotton gin, was also the father of interchangeability of parts. Shortly after the Revolutionary War he was given a contract for manufacturing muskets for the new United States Army. Instead of rushing into production by the hand methods common in those days, Whitney developed a number of gages for gaging the various parts that went into the muskets. He then had the parts made to fit these gages. The story is told that he walked into the office of the Secretary of War and dumped on that gentleman's desk enough parts to make ten muskets, with the challenge that any part would go into any musket.

Today, we consider this commonplace and we credit the system of interchangeable parts for giving us $1,200 automobiles; $200 refrigerators; and $30 vacuum sweepers.

However, the requirements of World War II made it necessary that this system of interchangeability of parts be refined still further. During World War I, we thought we had achieved perfection when we manufactured parts to one thousandth of an inch. The micrometer then was considered the perfect tool. However, during World War II, millions of parts were made to tolerances as small as fifty microinches. These parts were mass produced—in many cases by female operators. Dimensional requirements of such war items as the Norden bombsight, fire-control instruments and binoculars could not have been met with the measuring instruments and methods of production available to us twenty-five years ago.

Naturally, rejections and costs of production can be high when dimensional requirements are of the order of 0.0001" under the accepted method of production and inspection in common use a few years ago. In those days, it was the custom to inspect 100% and reject all parts not conforming to specifications.

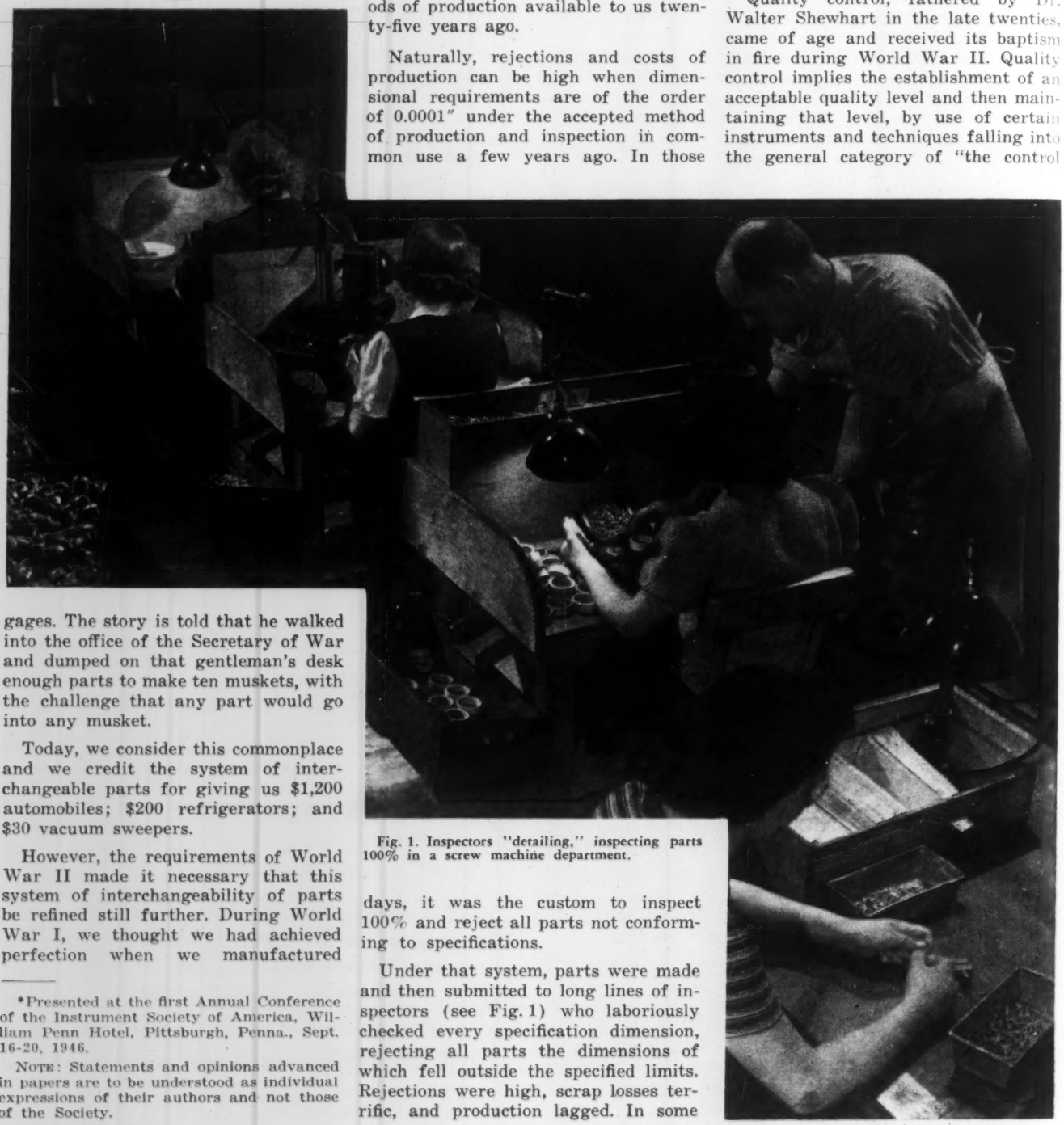

Fig. 1. Inspectors "detailing," inspecting parts 100% in a screw machine department.

Under that system, parts were made and then submitted to long lines of inspectors (see Fig. 1) who laboriously checked every specification dimension, rejecting all parts the dimensions of which fell outside the specified limits. Rejections were high, scrap losses terrific, and production lagged. In some instances, entire plants had rejections running as high as 90% of production, and still they continued in operation because of the urgency of requirement of the products they manufactured. One hundred percent inspection is still in vogue in some of the less progressive industrial plants, but it is recognized that this is an obsolete method for meeting high quality standards in production.

Quality control, fathered by Dr. Walter Shewhart in the late twenties, came of age and received its baptism in fire during World War II. Quality control implies the establishment of an acceptable quality level and then maintaining that level, by use of certain instruments and techniques falling into the general category of "the control

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*Presented at the first Annual Conference of the Instrument Society of America, William Penn Hotel, Pittsburgh, Penna., Sept. 16-20, 1946.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

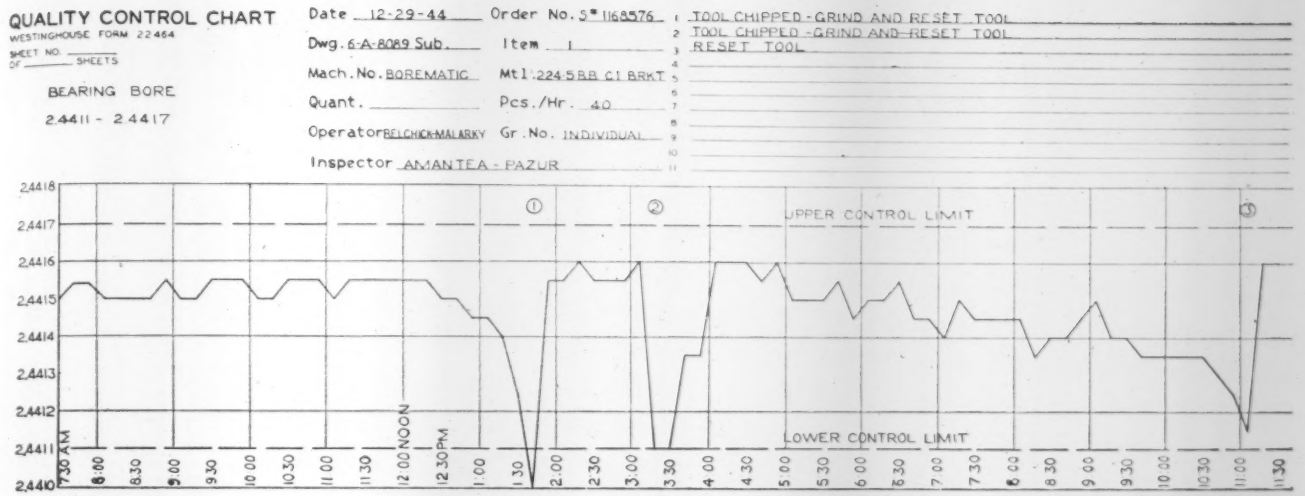


Fig. 2. The control chart controls quality by predicting the possible production.

chart system of controlling quality." See Fig. 2.

It is true that inspection must be performed on the parts in order to control quality, but the inspection is done with a different objective in view and, therefore, the methods are somewhat different from the 100% inspection used in the old days.

Two methods of inspection are generally employed for the purpose of controlling quality: the method of attributes and the method of variables.

The method of attributes recognizes only conformance or non-conformance of parts to a specification. It implies the use of "go" and "no-go" gages. The index of quality is generally the "fraction defective," or percent rejection. When parts are rejected as not conforming, we do not know the extent, or the amount, of their deviation from the specification. When parts are accepted, we do not know how close they conform to the specification. They might be perfect, or they might be barely within the specification limits, in which case they might be considered as border-line cases, as regards the level of quality desired. By the use of the method of attributes, we cannot "measure" quality. We can only say of a product that it is "good" or "bad."

The method of variables requires that the characteristic to be controlled be actually measured on a continuous scale, so that we know the closeness of conformity to the specification, or the amount of deviation of rejected parts from the specification, and measuring instruments are required for this purpose.

Instruments have been developed to measure many quality characteristics formerly considered impossible of measurement. The intensity and shade of color can be measured and the color given a numerical value according to the Munsell system. Odors can be measured and classified and any given odor can be definitely identified by a four-digit number. (Incidentally, we are informed by E. C. Crocker and L. F. Henderson, of Arthur D. Little, Inc., that only 6,561 different odors can be positively identified and classified by the human nose.)

The roughness of machined surfaces can be measured by any one of several instruments now available on the market. Ten years ago, the design engineer was accustomed to specify a surface on a drawing as "grind smooth," or "machine all over." In this manner the stage was set for a beautiful argument between the inspector and the operator, neither of whom really understood what the engineer had in mind when he said "grind smooth." See Fig. 3. Today the design engineer specifies the roughness of a surface by giving it a numerical value which is the average deviation of the peaks and valleys from a nominal line passing through the surface. This eliminates any possibility of misunderstanding and establishes a definite value for the quality of the surface. See Fig. 4.

Fig. 3. An operator "feels" a ground surface to determine its smoothness.

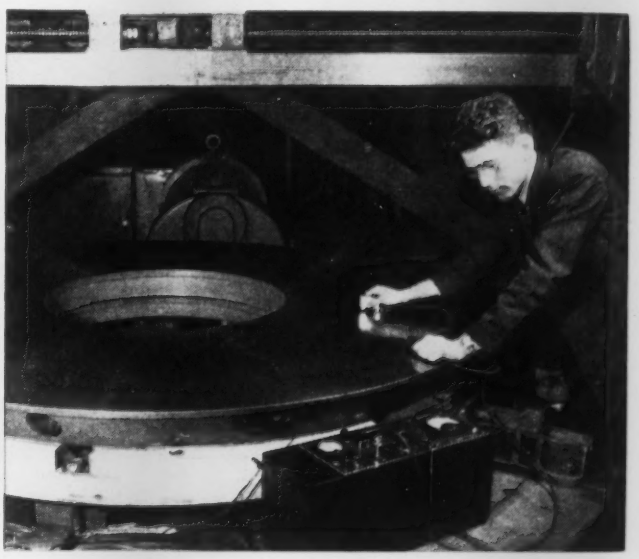


Fig. 4. An inspector uses an instrument for measuring the roughness of a surface.

Fig. 5. One corner of the gage laboratory containing the primary standards for calibrating secondary standards used by inspectors.

The ability to measure and the development of measuring instruments have made possible inspection by the method of variables.

There is some advantage in using the method of attributes as against the method of variables. Fixed gages are cheaper and require less skill in their use. It is generally more simple for the inspector to make a decision as regards conformity or non-conformity to a specification. However, these advantages are more than offset by the greater amount of inspection which must be performed in order to obtain the same information as is available from a smaller sample inspected by the method of variables.

Let us assume a simple case, such as an operation producing from 5% to 10% defective parts. If we gage five parts by the method of attributes, we might not find any defectives. We will then assume that these five were conforming to specifications and, therefore, are acceptable. But, we could make no prediction regarding the quality of the next five units which the operation might produce. However, if we measured these five pieces with indicating instruments, we could readily determine if the operation was producing parts which were near the bottom limit of the specification or the top limit of the specification, or near the mid-point of the tolerance limits.

Ordinarily, a sample of fifty pieces will give us enough information, when examined by the method of variables, to construct a control chart and thereby proceed to control the operation. (See Fig. 2.) However, from the same operation, we would need to examine from 200 to 400 units when inspecting, by the method of attributes, to obtain a sufficient amount of information to enable us to construct a control chart.

It is for this purpose that instruments have their greatest value in quality control work. However, there is one other point which makes instruments necessary, and that is, the close tolerances required on many parts. Without embarking on the old academic question of whether a one-inch plug can be inserted into a one-inch hole, we know that fixed gages are not satisfactory when used for inspecting parts which are made to tolerances of the order of tenths of thousandths of an inch.

Indicating instruments have one great advantage over fixed gages in quality control work — the reproducibility of results. Results obtained with fixed gages are somewhat dependent on the skill of the operator. However, the value of a quality characteristic measured with an indicating instrument is read on a dial or scale and any number of inspectors can get the same results. This is very important when guarantees of performance have to be met as disagreement on the part of inspectors might lead to costly legal tangles.

Indicating instruments of the electric or air type are available in any degree of sensitivity, making possible the choice of the best instrument for the job. Multiplications of ten thousand to one are easily obtainable with an electric gage and one thousandth of an inch on a part may be stretched to several inches on an air gage.

This feature of being able to multiply a measurement without distortion speeds up the inspection operation and increases the accuracy of the observation. This increased accuracy and speed of inspection alone makes indicating instruments indispensable in quality control work.

This brings up the question of sensitivity and accuracy of the indicating gages required for this work. The au-

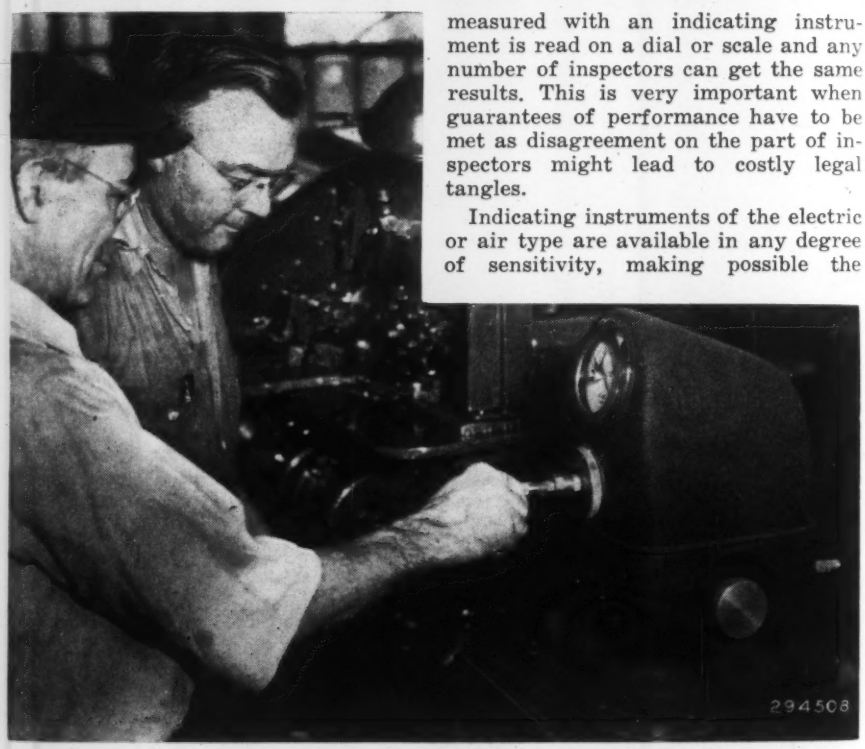


Fig. 6. An inspector instructs an operator in the use of a delicate air gage.

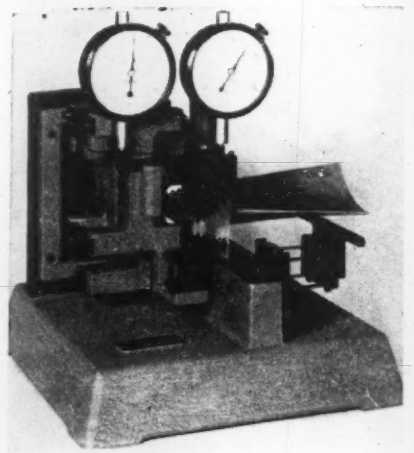


Fig. 7. Special gage used for measuring root thickness of gas turbine blades.

thor prefers to apply the 10% rule to this problem. Briefly stated, if a part is to be made to tolerances of the order of a thousandth of an inch, the gage used for measuring these parts should read directly to a ten-thousandth. Such a gage should be calibrated with standards reading to a hundred-thousandth —to ten microinches—and it is necessary to calibrate these secondary standands to primary standards which can be read to one microinch. Therefore, it is necessary for a shop which *works* to a thousandth of an inch to be able to *measure* to millionths of an inch, if it is to control quality properly and economically.

A Gage Laboratory (see Fig. 5) properly equipped for the work performed in the plant, is a necessary adjunct to the quality Control Department. This Laboratory *must* be temperature-controlled to assure dimensional constancy of standards; and it should be humidity-controlled to prevent condensation of moisture on valuable gages. When gages are brought into the Gage Laboratory for calibration, they must be given enough time to come to the same temperature as that of the primary gages to be used in their calibration. Conversely, gages cannot be taken out of the Laboratory and into the shop and used immediately. They must be allowed to come to equilibrium at shop temperature.

Now that we have decided that indicating instruments are necessary to control the quality of products during manufacture, the question comes up—shall the inspectors use these instruments, or should operators be given these expensive gages to use? The author really sees no problem here. If Management is satisfied to give an operator a $50,000 machine to amuse himself with, certainly that operator should be trusted with a $500 gage. Operators should be furnished with gages of the same sensitivity and accuracy as those used by the inspector in his regular inspection work. See Fig. 6. The policy of having one standard of gages for the worker and one standard of gages for the inspector is obsolete. When used in the past, it resulted in poor quality of product, higher costs, and continual wrangling between operator and inspector.

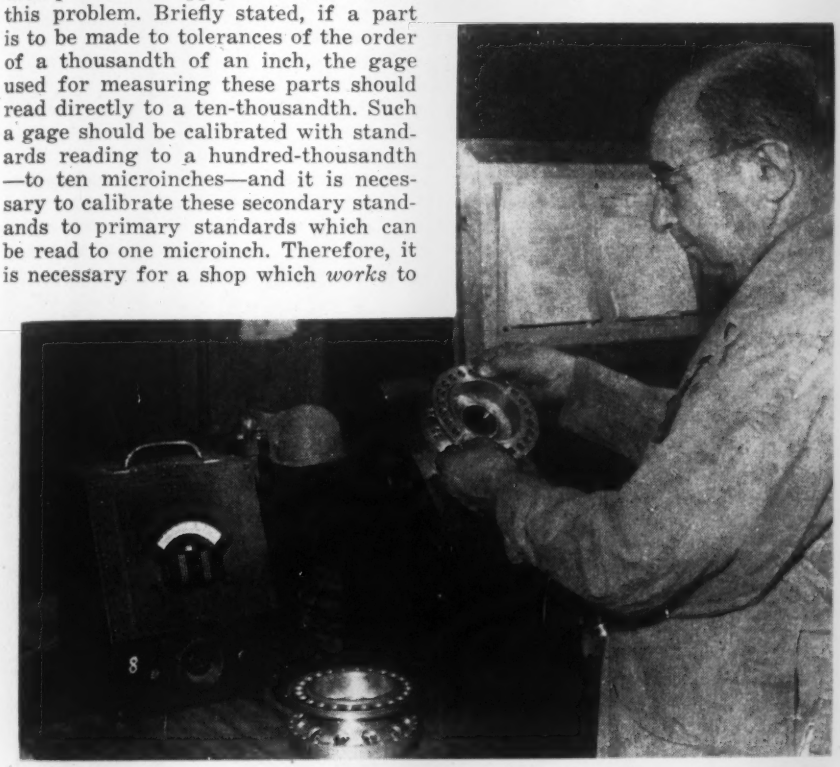


Fig. 8. Gage used for measuring the concentricity of the bore with respect to the mounting fit of a generator bracket.

Complex contours may require the use of specially-designed gages such as that shown in Fig. 7, used for measuring the thickness of the root of gas turbine blades. When dimensions must be maintained within extremely close tolerances with respect to each other, special gages can do the job quicker and better. The gage shown in Fig. 8 is used for measuring the eccentricity of the bearing fit with respect to the bracket fit on a generator mounting bracket and can gage several pieces per minute.

Special gages are designed around available measuring instruments. This reduces their cost and simplifies their construction. They require less skill in their use, thus making them available for use by female inspectors of limited mechanical aptitude.

Naturally, a program embracing the extensive use of indicating instruments, such as electric gages, air gages, and optical projectors, involves a considerable amount of capital outlay, and the question might be proposed "Does such a program pay off?" The answer is emphatically "yes," provided that the gages are used for controlling quality and not merely for evaluating the quality after the products are made. Such a program of quality control, by use of the method of variables, will reduce rejections to any desired level. In continuous machine operations, experience has shown that rejections can be held to less than one-half of one percent. This makes possible the full utilization of productive equipment. An operation which is producing 20% defective parts is really utilizing 80% of the available equipment—five machines are doing the work of four. Fig. 9 shows the increase in production when quality is properly controlled by the use of measuring instruments.

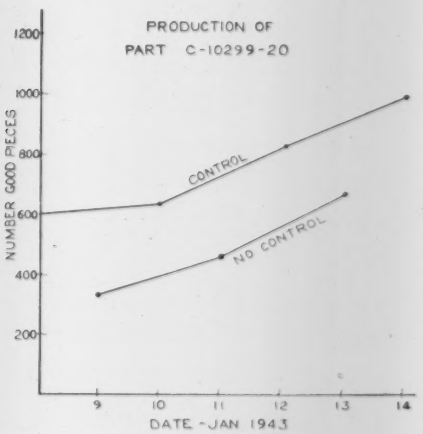


Fig. 9. Production is increased by more than 40% when quality is controlled by means of the control chart and measuring instruments.

The manufacturer is interested in total unit costs; that is, cost as determined by the cost of material, labor and overhead. The investment in inspection instruments can be justified only if such investment increases production or improves quality to the point where costs are reduced sufficiently to amortize the cost of the instruments. Experience has shown that instruments will pay for themselves many times over if properly applied to the job.

It appears to the author that any program which increases production, lowers unit costs and improves quality is a good program to hitch our wagon to.

Location of Internal Defects by Supersonics*

By J. W. DICE, Sperry Products, Inc., Hoboken, N. J.

WITHIN the last year or two, the word supersonics has been tossed around quite a bit. If you talk to an aircraft designer, supersonics to him means a plane traveling at a speed higher than the speed of sound. Others say that supersonic sounds or frequencies are anything that can't be heard by the human ear; still others claim that sound waves don't become supersonic until they are approximately 500 times shorter than the wave-length of middle C on the piano. Another school of thought says that the term supersonics should be applied to those high-frequency sounds which are in the death-ray group. In non-destructive testing by means of super-

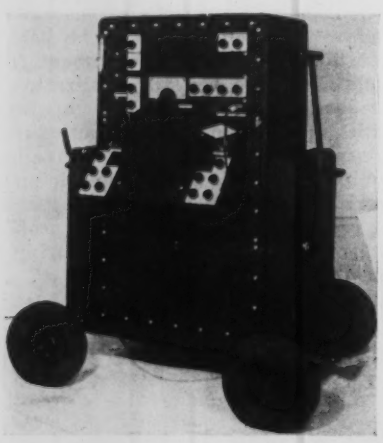


Fig. 1

sonic sound waves, we consider any sound wave to be supersonic when it is beyond the range of hearing of the human ear. A person with normal hearing can hear sounds having a frequency of around 16,000 cycles per second.

Many people have for years been using low-frequency, or audible, sound waves for a form of non-destructive testing. Your wives undoubtedly thump cantelopes or watermelons to test them for ripeness. Tapping of car wheels is an example used in industry. Going back into history, you will remember that the sword-maker of Toledo would test his Damascan blades by listening to the ring of the metal.

The principle of operation of the Sperry Supersonic Reflectoscope, Fig. 1, is that it sends supersonic vibrations through the material under test and measures the length of time it takes these vibrations to penetrate the material, reflect from the opposite side, or from an internal defect, and return

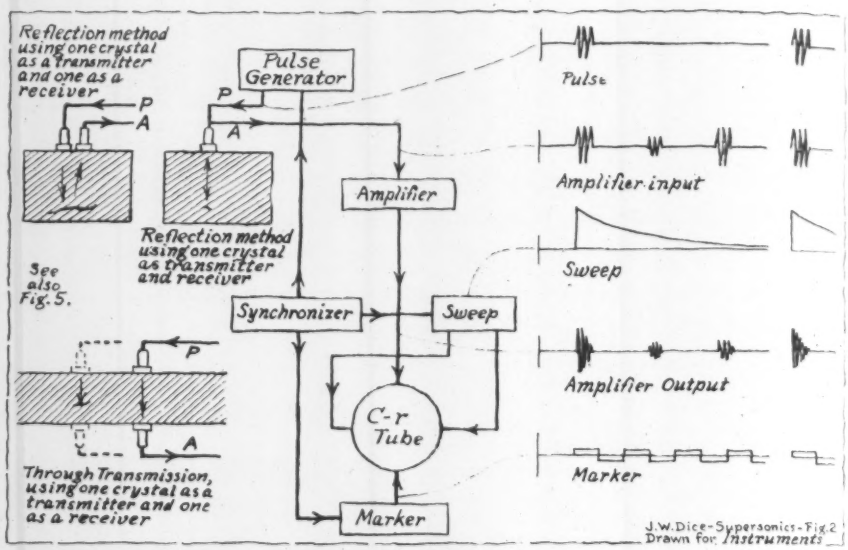


Fig. 2

to the sending point. The pattern on an oscilloscope screen provides a visual indication of the location of any defects that may be present in the material. In the cabinet, we generate high-frequency electrical impulses of the order of one-half million to twelve million cycles per second. These electrical impulses come out through a regular television coaxial cable to a quartz crystal scanning unit. This quartz crystal deforms with the application of electrical impulses, so if we put million-cycle frequency electrical impulses in the back of the quartz crystal scanning unit, out the front we get a sound beam of

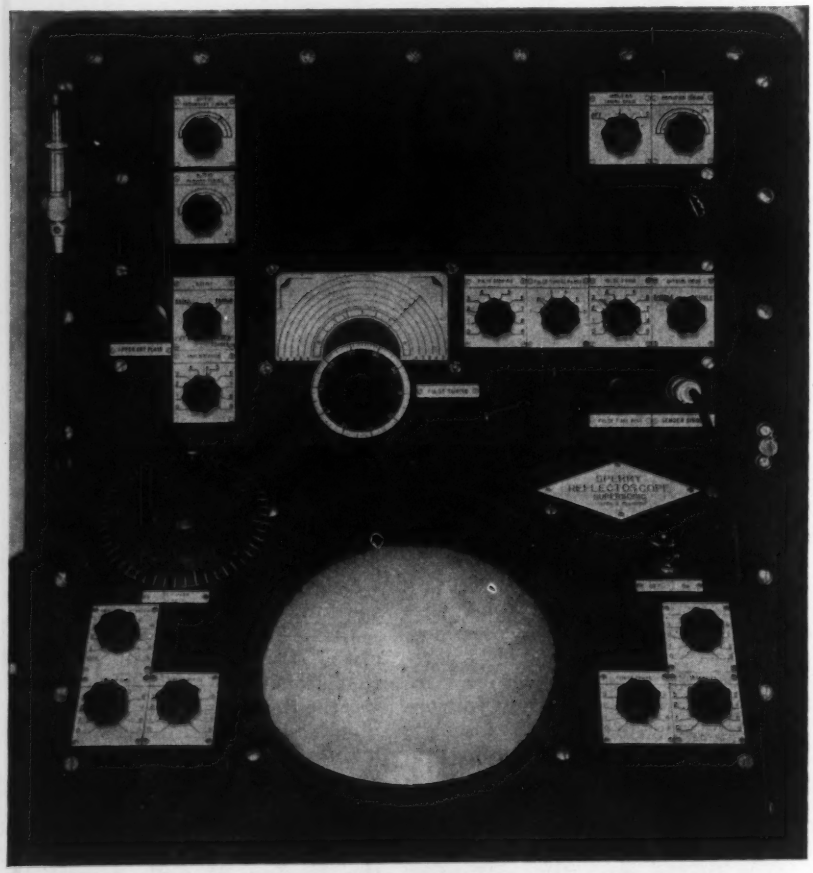


Fig. 3

*Presented at the first Annual Conference of the Instrument Society of America, William Penn Hotel, Pittsburgh, Penna., Sept. 16-20, 1946.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

Fig. 4

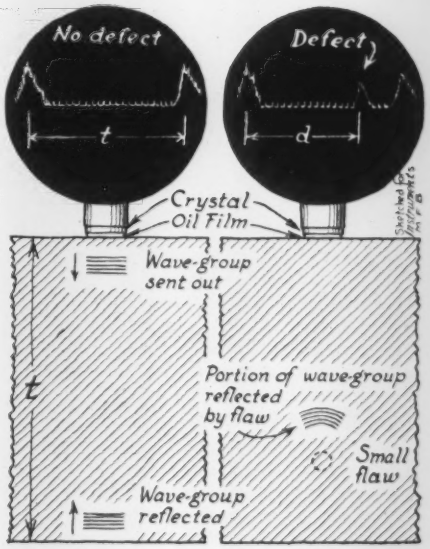


Fig. 5

million-cycle frequency. This beam travels in a straight line, just as a flashlight beam. If you directed a flashlight beam on the opposite wall, light would be reflected from the wall. If a person walked in the path of the flashlight beam, light would be reflected back from that person. Exactly the same action takes place with the supersonic beam emitted from the scanning unit. Sound goes out, bounces back from any defect, the same crystal receives the returning sound wave and transfers the reflected pulse to the unit where it is amplified and sent to the 'scope screen.

The functions of the various circuits involved are shown in Fig. 2. The synchronizer provides three different output pulses sixty times a second. The first pulse is the rapid rise and exponential decay of the sweep voltage. The second pulse starts and stops the distance markers and may be delayed with respect to the sweep by a variable amount in order that the inch marks may be moved along the sweep. The third pulse is also delayed by a variable amount and determines the point at which the supersonic pulse generator is started. The sweep amplifier provides push-pull horizontal deflection for the cathode-ray tube. The time of travel of the spot across the screen may be varied from 10 microseconds to 2000 microseconds approximately. Sweep expansion is also provided to obtain good resolution over long distances.

The distance marker generates square waves in which the fundamental frequency is continuously variable from 5 kc. to 130 kc. Therefore, one square-wave cycle can be made to represent any desired length from one to more than twenty-four inches of the material.

The pulse generator provides a 1000-volt pulse and is continuously variable in overlapping ranges of frequencies from 0.5 megacycle to 12 megacycles. The pulse length may also be varied from one to several microseconds.

The amplifier is actually a superheterodyne receiver, all the reflected pulses being converted to one frequency before being amplified. Its band-width is variable from a fraction of a megacycle to several megacycles. Since sound absorption and the minimum size of the defect to be located vary with each application, the amplifier gain is variable. The indicator is a nine-inch cathode-ray tube.

You will note that in the lower left-hand corner of Fig. 2 the use of separate crystals to act as Transmitter and Receiver may be accomplished. This modification is used by Sperry on another instrument, the Supersonic Thru-ray. The Reflectoscope, however, uses only the one crystal to act as both Transmitter and Receiver.

Fig. 3 shows a close-up view of the Reflectoscope control panel with the various control adjustments.

Under actual test conditions, in order to obtain good supersonic coupling, a film of liquid, usually oil, is spread over the surface of the material before applying the searching unit. In Fig. 4 you will note the oil can placed handily on the testing table for this purpose. Before I leave the subject of crystals I should like to mention that cylindrical surfaces may be tested either with specially-ground crystals or with the standard searching unit, depending on the radius of the piece under test. Any cylindrical material with a diameter of 4" or more may be tested with the standard searching unit. For cylinders of smaller diameter the crystal should be ground to fit the piece being tested; also, both surfaces of the crystal must be curved in order to make the crystal a good transducer.

Fig. 5 shows the action of the sound beam as it goes from the quartz crystal through the material. This X-cut crystal is used as an electromechanical

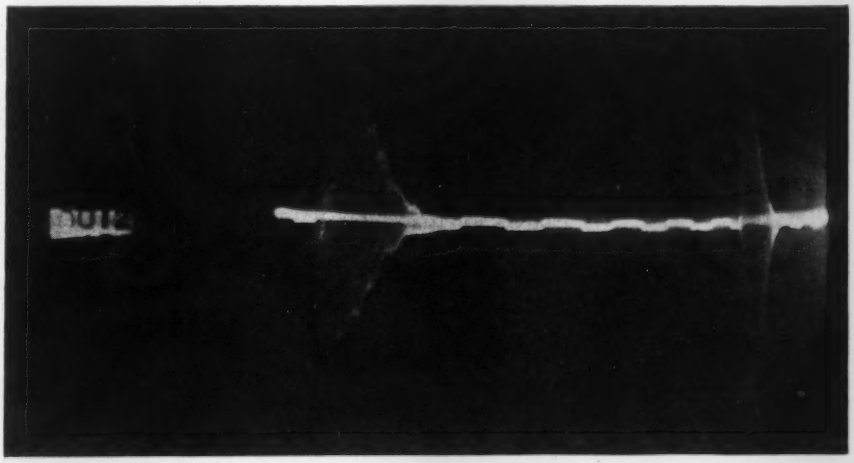


Fig. 6

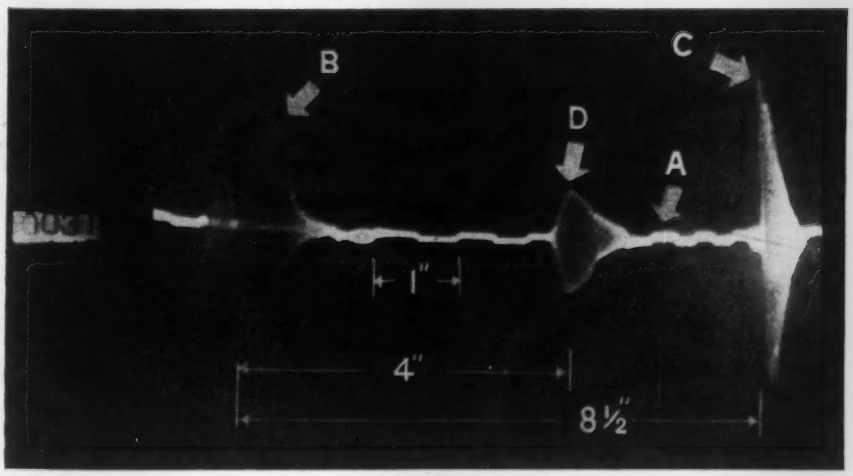


Fig. 7

Material	Velocity 1000 in/sec.	Wave-lengths/(in.) at Frequencies: 1 Mc.	2¼ Mc.	5 Mc.
METALS				
Aluminum	245	0.245	0.109	0.049
Steel	229	0.229	0.102	0.046
Nickel	219	0.219	0.097	0.044
Magnesium	210	0.210	0.093	0.042
Copper	182	0.182	0.081	0.036
Brass	174	0.174	0.077	0.035
Lead	84	0.084	0.037	0.017
Mercury	56	0.056	0.025	0.011
PLASTICS				
Glass	205	0.205	0.091	0.041
Polystyrene	105	0.105	0.047	0.021
Bakelite	102	0.102	0.045	0.020
LIQUIDS & GASES				
Water	57	0.057	0.025	0.011
Oil (Transf'r)	54.7	0.055	0.024	0.011
Air	13.9	0.014	0.006	0.003

Fig. 8

transducer and is normally operated near its thickness resonance to obtain maximum sensitivity. As used in the Reflectoscope, the crystal is one-half wave-length thick. It is clamped to damp out free vibrations rapidly and a metallic coating is provided on the back side to serve as one electrode. The material under test will, of course, constitute the other electrode. The wave train on the right and left picture the sound going completely through the material and being reflected from the opposite side.

Fig. 6 is a photograph of the oscilloscope screen of a Reflectoscope, showing the picture you would see when testing good material. It gives the operator a complete picture of the interior condition of any material he is testing. The line through the center is known as the sweep line. As mentioned before, this can be set easily by the operator so that each square wave indicates any measure of distance from one inch to two feet. At the left is what we call the initial pulse. This is at the surface of the quartz crystal and remains on all the time that testing is being done. At the right you see sound being reflected from the far side of the test piece.

In Fig. 7, near the center, there is an indication of sound being reflected from a defect in the material. By counting the square waves from the initial pulse to the defect, or from the back reflection to the defect, the depth of the defect can be immediately determined. By moving the scanning unit over the surface of the material as you are testing and watching the oscilloscope screen, it is easy to trace out the pattern of any cracks, voids, inclusion or porosity area which may exist. Scanning the interior of a casting or any other material for defects can be done as quickly as the operator can move the crystal over the outside surface.

We come now to a consideration of the actual testing problems. One of the most important of these is projected by the velocity of sound through the material, which will to some extent affect the depth of penetration possible. The velocity of sound waves traveling through a solid depends upon the density and the elastic properties of the

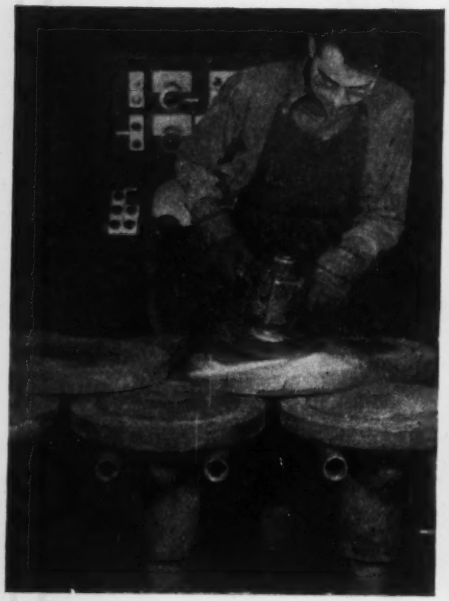


Fig. 9

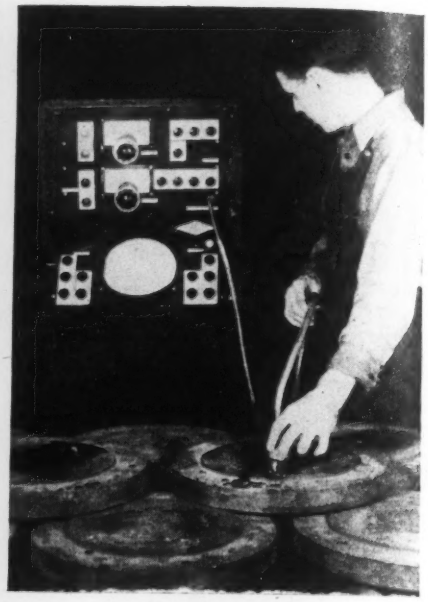
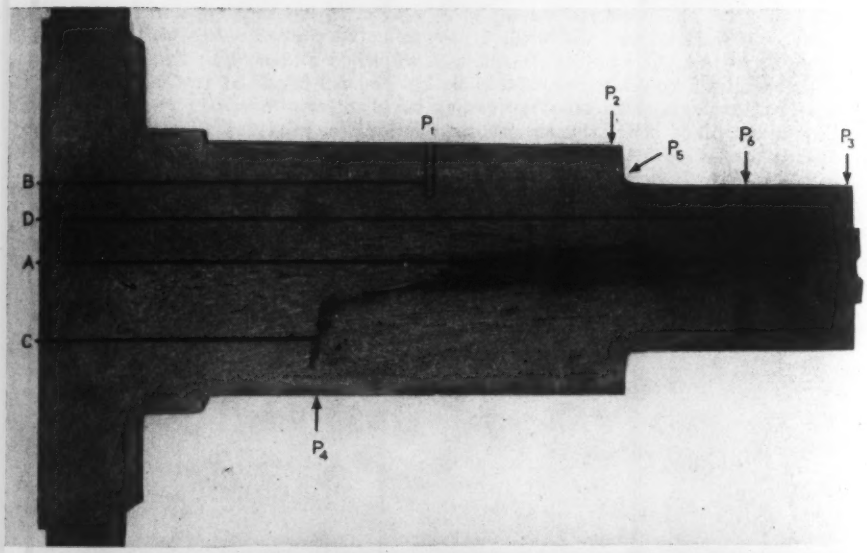


Fig. 10



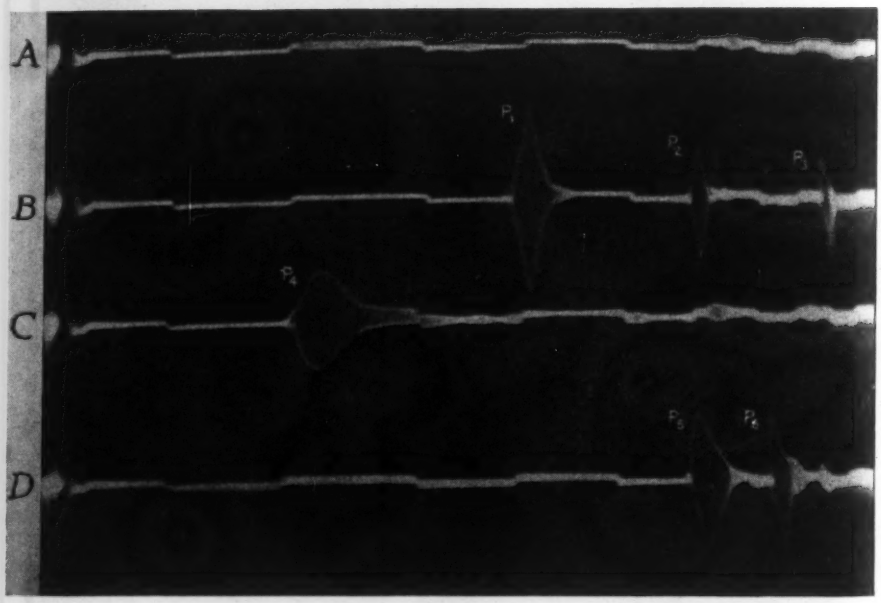


Fig. 11

material. The two elastic properties involved are, first, the expansion or contraction of a body caused by a given force (the ratio of the stress intensity to the strain produced by that stress) and, second, the unrestricted change in width caused by a given change in length (the ratio of the compressional strain to the tensile strain, or vice versa). These are fundamental properties well-known in the field of applied mechanics as Young's Modulus and Poisson's Ratio, respectively.

On the chart, Fig. 8, at the upper right hand side, you will see that the wave-lengths normally used for testing are listed. Following the first column "1 Mc." down to a point where it is intersected with the material "steel" along it can be seen that at 1 Mc. the sound will travel 0.229" (or approximately ¼") per cycle. A little further down, still at the same frequency, it can be seen that at 1 Mc. the sound beam will travel through lead 0.084" (or slightly less than 1/10") per cycle.

Before actually testing the material it is necessary to check the surface for proper conditioning. In order for the crystal to seat itself properly and to maintain a good supersonic coupling, it is necessary first that the surface be smoothed to a GE standard of f4 or f5. This preparation is not at all difficult, and may be accomplished with a hand grinder or sander, as shown in Fig. 9 where forged axles are being prepared. The hand grinder will knock off the high spots and will allow the crystal—with the aid of a film of oil, as previously discussed—to make good contact. Fig. 10 shows the operator applying his searching unit to the axles being tested and watching the oscilloscope screen while he moves the searching unit over the surface of the material.

Fig. 11 shows a cut-away view of a defective axle and a set of the corresponding oscillograms taken at the four locations shown on the axle. You will note that when the crystal was applied to point *B* on the axle, the corresponding indications on the oscilloscope show that a crack is indicated at point P_1. The shoulder is shown reflected at P_2 and the back reflection from the end of the axle is seen at P_3.

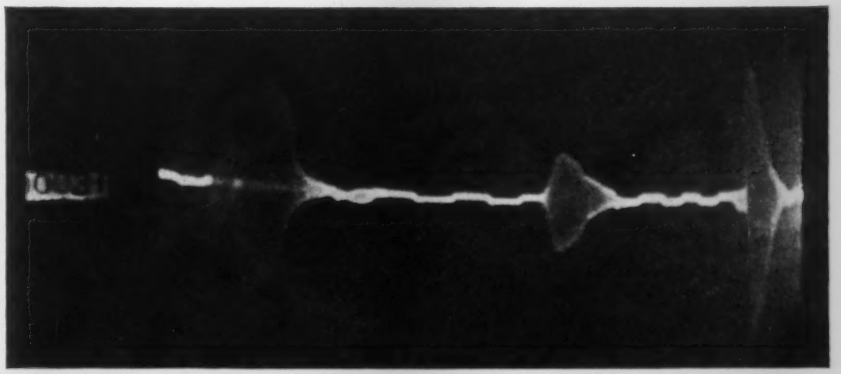
When the crystal is applied at point *D*, a crack indicates at point P_6 and the shoulder of the axle at P_5.

At location *C*, the beam strikes a crack which is wide open, thereby blocking all the sound from going through to the other end of the axle. This defect is shown at P_4.

When the crystal is applied to location *A*, the beam strikes a highly-segregated area which disperses all of the sound beam so that none is reflected from the other end of the axle. This in itself is an indication that defects are present, although there is no indication such as you have seen at the other locations.

Fig. 12 shows a typical defect indication obtained from the edge of a crack in a large casting. Note that part of the sound wave is going around the edge of the crack and is being reflected from the other side of the casting. As we move our searching unit over the crack, you will note that the crack indication in the next illustration (Fig. 13) appears much larger, while the reflection from the other side appears smaller. Thus we have located the interior defect.

Fig. 12



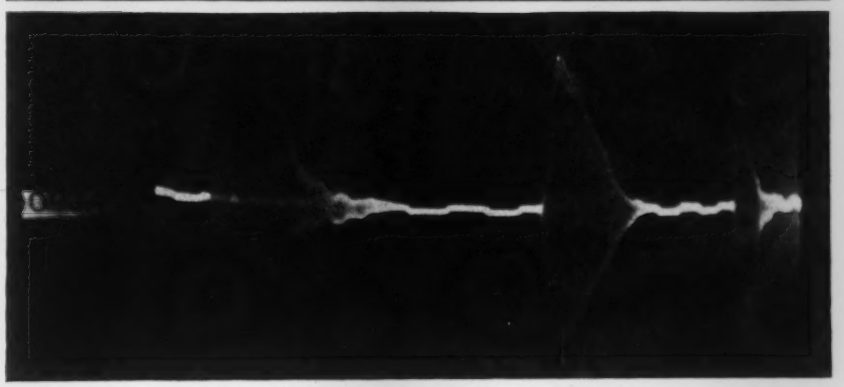


Fig. 13

The Reflectoscope has the ability to pick up minute internal defects in metals which would not show up on an x-ray. Using the proper testing frequency, it is possible to pick up defects whose diameter is one or two thousandths of an inch, at distances up to 6" away from the crystal. A rough rule-of-thumb measurement of the accuracy of the Reflectoscope is that it will pick up a defect whose diameter is one-tenth of one percent of the distance you are shooting. In other words, at a distance of ten feet from the crystal, 0.1% would mean a defect ⅛" in diameter. An example of these extremely small defects is a billet with many small flakes, shown in Fig. 14. You will note that the defects are scattered throughout its section, all of minute proportions. [EDITOR'S NOTE.—For this very reason, the defects were hardly visible on the screen and would not show up in an illustration less than page size.] Fig. 15 is a reflectogram which shows the defect indications obtained from the flaking in the billet which was just shown. You will note that these flakes occur at various levels throughout the section.

Since the Reflectoscope will locate minute defects in material and may be applied wherever a penetration into the material in the order of ten feet is required, it may be used in industry for the quality control of materials during production: in the raw, semi-finished, and finished stages, or at all three of these stages. It will indicate on the oscilloscope screen any area of discon-

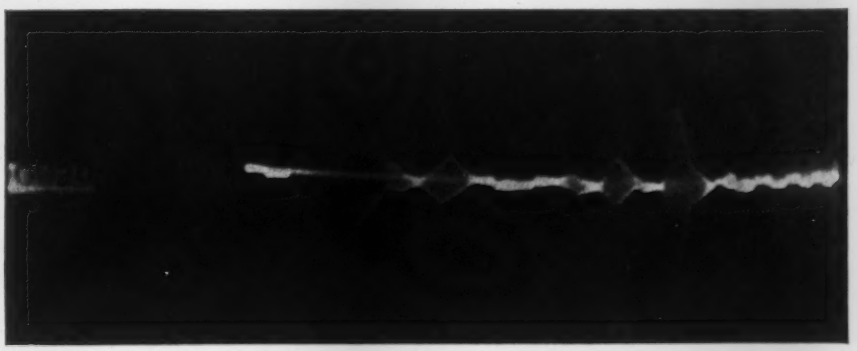


Fig. 15

Fig. 16

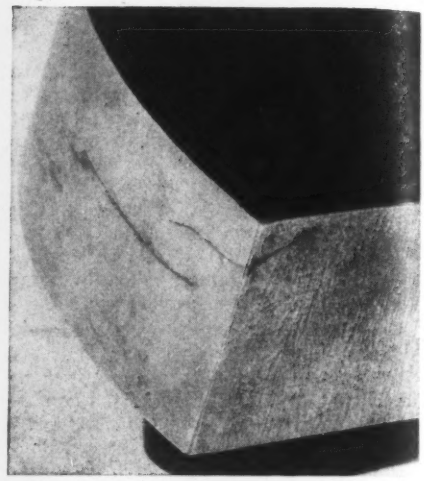


Fig. 17

tinuity. We have spoken of flakes and cracks almost exclusively, but the instrument will also discover inclusions, laminations, voids or in short all of the important internal defects which are hazards in controlling the production of quality materials.

Another type of testing with the Reflectoscope, now being used extensively, is testing for fatigue cracks on assembled equipment. In Fig. 16 you will notice that the Reflectoscope is testing the crank-pin of a steam locomotive. The axle can also be tested successfully. Fig. 17 shows a sectioned piece showing a locomotive crank-pin which reveals flaws first detected with the Reflectoscope. This particular crack was 10" long and only ½" deep and was found by testing from the large end or inside of the crank-pin.

I would like to mention that the Supersonic Reflectoscope was invented by Dr. Floyd A. Firestone who was formerly Professor of Physics at the University of Michigan and that the technical development of the model which we have spoken of here was under the direction of H. C. Drake, Director of Research at Sperry Products, Inc. We at Sperry feel that the experimental stages of development are over. Much research remains to be done on individual testing applications. Sperry, of course, is going ahead with its own research in this direction but, meanwhile, many valuable contributions are coming in from Reflectoscope users in industry. To mention only a few, Mr. O. R. Carpenter of Babcock & Wilcox has been responsible for much valuable research on the use of the Reflectoscope as applied to welded plate in pressure vessels. Mr. J. V. Russell and Mr. H. E. Pellett of Republic Steel Corporation have also given much time and attention to the Reflectoscope as applied to steel billets and blooms in the early stages of development. The Aluminum Company of America has also been most coöperative in conducting tests on their products.

Automatic Control for Aircraft*

By JOHN C. NEWTON, Sperry Gyroscope Co., Garden City, L. I., N. Y.

AUTOMATIC control of an aircraft may be defined as the constraint of an aircraft to a predetermined attitude and airspeed. By attitude is meant the alignment of the airplane's major geometric axes with reference axes which are *angularly* fixed with respect to the earth. Controlling attitude and airspeed, of course, controls direction and speed of flight and therefore defines a flight path, but only with respect to the air mass which contains the airplane. Since the airplane's velocity and the wind velocity add vectorially, the path with respect to the earth may be quite different. Control of an aircraft to a path defined with respect to the earth, which is necessary for flight from here to there, is a navigational as well as a control problem. As such it is outside the primary scope of this paper, but the two are too closely related to permit complete omission of the navigational aspects.

For several reasons it is highly desirable to closely constrain an aircraft to a flight path as defined above.

During automatic approaches or landings in zero weather, the aircraft must follow a radio beam down on to the runway, or at least to just a few feet above it. With aircraft weighing in the vicinity of fifty tons approaching at speeds from 120 to 160 mph. along a path which is inclined only 2½° to the earth's surface, it is highly important that control be provided to hold the aircraft firmly and accurately on the proper path. In such circumstances the plight of the man who zigged when he should have zagged would be idyllic compared to that of the control system which wobbled when it should have been tight and dead-beat.

Passengers in transport aircraft are uncomfortable only when they are subjected to varying acceleration forces. So far as any one knows, the speed of a vehicle may be far beyond anything yet attained without unpleasant effect on its occupants so long as that speed is reasonably constant both in direction and magnitude. During flight through turbulent air it is not possible to maintain a truly linear space path. Close, dead-beat control of attitude does provide comfortable flight, free from angular accelerations of the aircraft which would be unpleasantly evident to passengers. And flight that is comfortable for human cargo is also non-hazardous for fragile freight.

The effectiveness of military aircraft in bombardment is so dependent on accurately following the proper ground track and maintaining altitude that automatic control is practically a necessity. Safety in formation flying on long missions will also be greatly enhanced by a control system accurate and tight enough to permit its use under such conditions.

A well-designed airplane by itself, without any automatic control equipment at all, has inherent short-period stability to a marked degree. As long as the air mass through which the plane is flying is inert and undisturbed, this *aerodynamic* or weather-vane stability is sufficient to maintain an almost linear flight path. Air is seldom totally inert. Usually it is full of local currents which may have almost any direction, and vary in strength from gentle zephyrs to violent gusts. Left to its own device the airplane responds to its own stability characteristics by trying to weather-vane into each gust it meets, and flies a course which, in even mildly turbulent air, is anything but straight and level. It is the duty of the automatic control system to substitute stable earth references for the variable references supplied by aerodynamic stability in turbulent air. By actuating the airplane's control surfaces (the rudder, ailerons, and elevators) the system should keep the airplane's three major geometric axes continually aligned with corresponding earth axes. These reference axes are usually provided by two gyroscopes, one

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with its spin axis horizontal furnishing a directional or azimuth reference, and the other with its spin axis vertical providing the roll and pitch references.

Since the automatic control system operates to keep the airplane aligned with fixed references, while the aerodynamic stability tends to keep it aligned with a wind reference which may be constantly shifting, it should be apparent that the automatic control system, to fulfill its function, must be capable of applying corrective moments which are appreciably higher than the aerodynamic stability moments. It is true that the disturbances due to gusts sometimes tend to average out and that the application of small corrective forces by the automatic pilot will maintain a correct *average* flight path, but not one which is free from disturbing angular accelerations. In an automatic approach in fog or blinding snowstorm, for instance, it is not only the average flight path accuracy that is important, but also the instantaneous accuracy with which the desired path and altitude are maintained. Only by maintaining a proper ratio between automatic-pilot stability and aerodynamic stability can a system be provided which will firmly and positively control an airplane to the desired path, rather than coax it or nudge it back after a disturbance.

(In this connection I am reminded of the comment of my instructor in light plane flying. I had read a lot about the inherent stability of airplanes and, during the first few hours of dual instruction, I was quite prone to give the plane its head, applying only very gentle corrective forces to the controls. The result was that the little Cub responded to every vagrant air current and rolled, yawed, and pitched to a degree that was by no means dangerous, but nevertheless uncomfortable and resulted in a decidedly tortuous and uneconomical path through the air. The instructor would stand this for just about so long, then turn and ask rather scornfully, "Say, are you flying this airplane, or just letting it take you on a tour?")

Some idea of the general power level required in the servo system for good automatic-pilot control may be had by considering that the control system of practically every airplane ever built was designed to provide adequate control when actuated by the muscles of an average human being. It is generally accepted that the average man can comfortably develop, for short intervals, from ⅛ to ¼ horsepower. Since the human pilot finds it necessary to develop his full mechanical output quite often during flight through turbulent air, it is evident that servos of this power range will be required in order to equal or exceed the precision of control exercised by the human pilot. Experience with gyropilot installations in a wide range of airplane types bears out this conclusion.

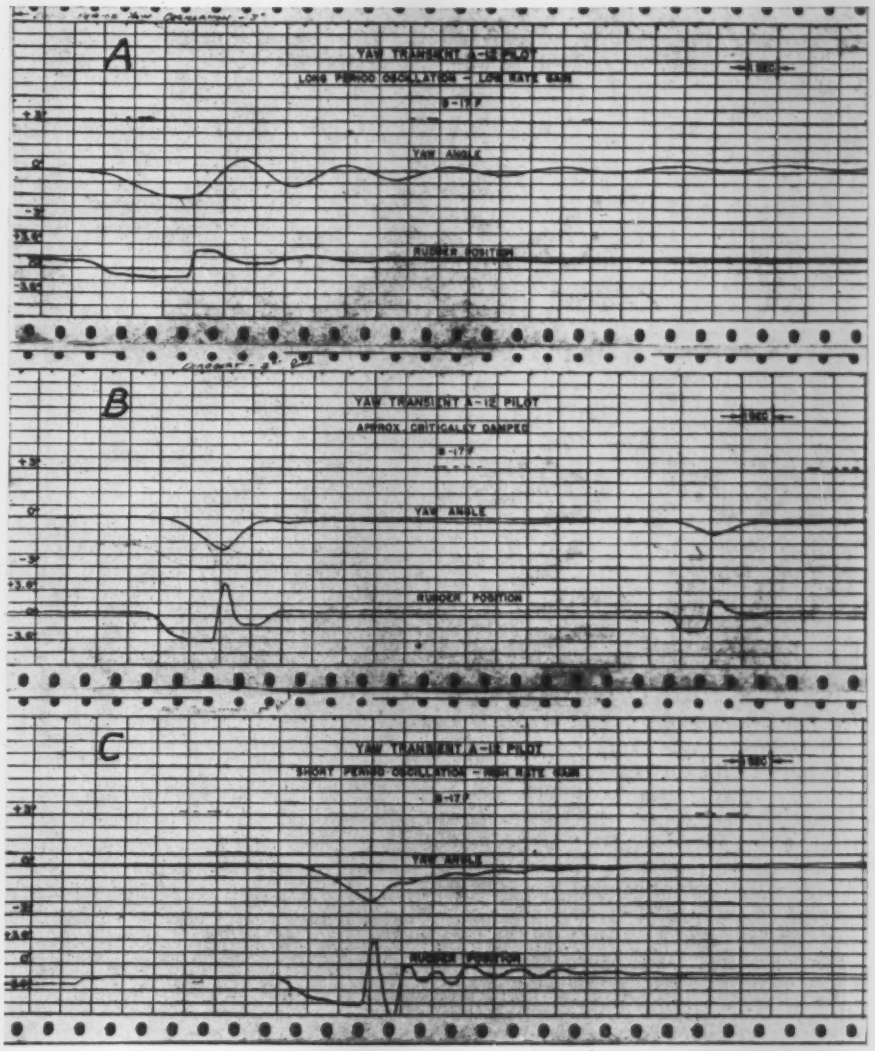


Fig. 1

An automatic control system with adequate mechanical output is incomplete without the proper error detecting and amplifying means to command that output. For good control, not only the *extent* of departure from the proper attitude must be detected, but also the *rate* of departure. Numerous types of automatic pilots have been built which omitted the rate element and applied correcting moments proportional only to the extent of departure. In such a system the corrective or restoring moment increases to a maximum as the airplane departs from its reference attitude, then decreases as the airplane returns. In order to prevent the departure from becoming excessive, the corrective moment per degree of attitude departure or error must be large. When it is made large, however, the angular velocity of the airplane during the return swing likewise becomes large. Since the restoring force is continuously applied, though in steadily decreasing magnitude during the return, the airplane will still have some angular velocity when it reaches the reference attitude Its own inertia will, of course, cause it to overshoot, calling for a corrective moment in the opposite direction to again return the airplane to neutral. This cycle will repeat until the stored energy is dissipated in the aerodynamic damping, as is shown in Fig. 1A.

Like any well-planned servo system involving high inertia loads, the modern high-performance Gyropilot system provides a rate or damping component of corrective force to eliminate the tendency of the system to oscillate. This is accomplished by making the restoring moment proportional to the extent of departure or error, plus the rate, or first time derivative, of that error. In such a system, the corrective moment is applied *rapidly* at the *beginning* of the disturbance. Because the rate component adds to the amount, or displacement component, full corrective effort is applied for smaller errors than would be the case in a pure displacement system. (Fig. 2B.) As soon as the departure has been checked the rate component drops to zero (Fig. 2C), reducing the restoring moment to that called for by the amount component only. And as soon as the airplane starts to return to the proper attitude, the

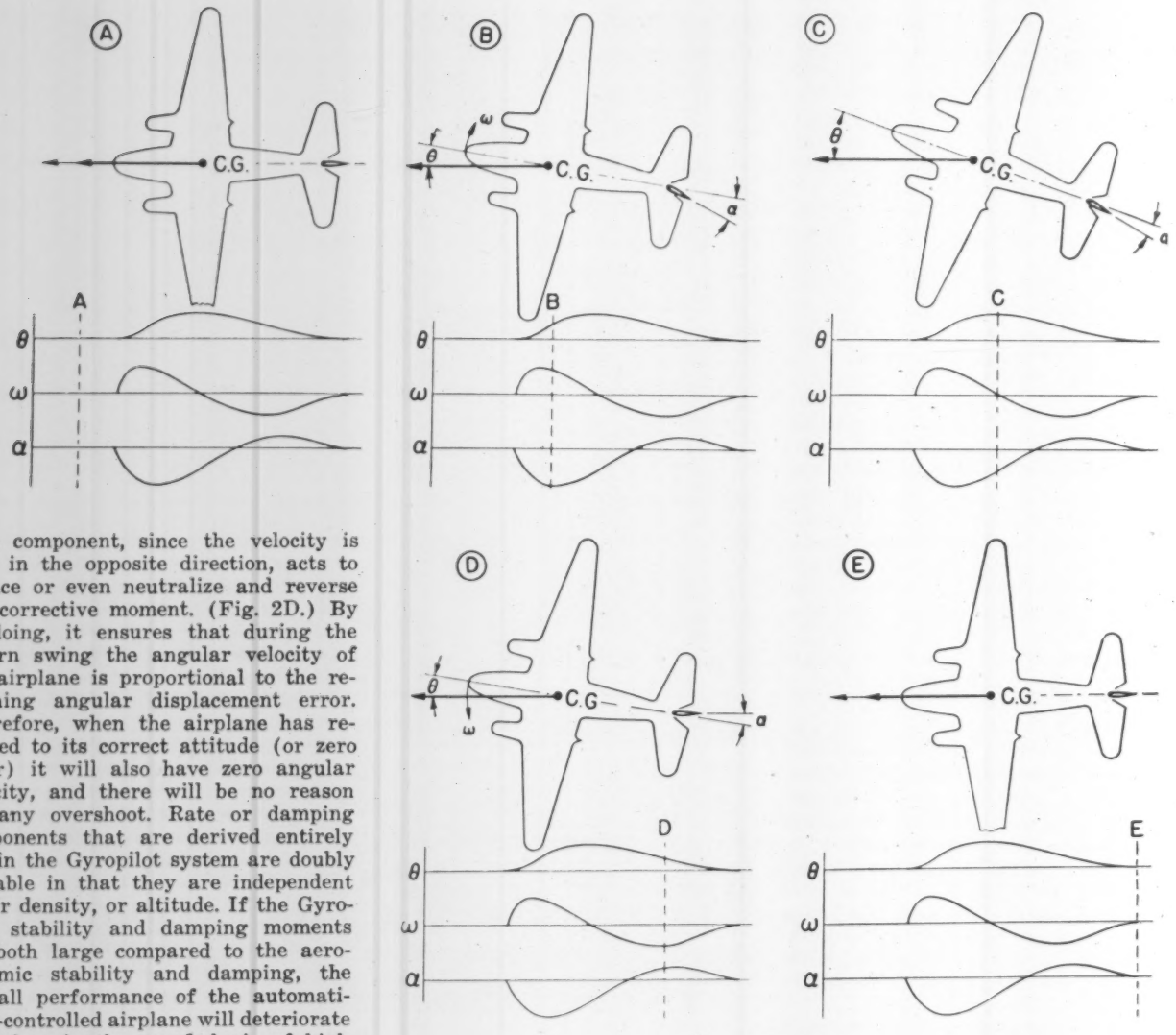


Fig. 2

rate component, since the velocity is now in the opposite direction, acts to reduce or even neutralize and reverse the corrective moment. (Fig. 2D.) By so doing, it ensures that during the return swing the angular velocity of the airplane is proportional to the remaining angular displacement error. Therefore, when the airplane has returned to its correct attitude (or zero error) it will also have zero angular velocity, and there will be no reason for any overshoot. Rate or damping components that are derived entirely within the Gyropilot system are doubly valuable in that they are independent of air density, or altitude. If the Gyropilot stability and damping moments are both large compared to the aerodynamic stability and damping, the over-all performance of the automatically-controlled airplane will deteriorate much less in the rarefied air of high altitudes than will be the case if aerodynamic damping alone is available.

To obtain the performance just outlined, the control system must meet two major conditions:

(1) The means for detecting and interpreting departures of the aircraft from proper attitude must have high accuracy and low time lag. They must furnish to the input end of the servo system a signal which ideally is instantaneously proportional to the amount of error plus the first time derivative of that error. An amount signal meeting these requirements is readily obtained by mounting a Selsyn, voltage-dividing resistor, or other type of signal pick-off on a displacement gyro. The rate signal may be obtained from a similar type pick-off mounted on a rate gyro, or by differentiating the signal from the displacement gyro. In either case the means used for producing the rate signal must have a time constant which is properly matched to the natural period of the airplane plus its automatic control system. Satisfying this requirement generally means sacrificing considerable sensitivity in the rate signal element. However, if this time constant relationship is not maintained, the signal from the rate element will not be proportional to the instantaneous angular velocity, but rather will be proportional to the average velocity taken over an appreciable time interval. As such it will lose much of its value as a damping signal.

(2) The second major condition to be fulfilled is that the servo system shall have low phase lag at the frequencies at which it is called on to operate. In other words, it should be capable of deflecting the control surface to an angle which is almost instantaneously proportional to the servo input signal. And it must, of course, have high power gain in order to develop the required output in response to signals which are ordinarily of very low power. By careful design it is possible to build pneumatic, hydraulic, or electric servo systems meeting these requirements. At present some form of electric motor, controlled by an electronic amplifier, appears to afford the best combination of ruggedness, simplicity and low weight for the performance required. To obtain the necessary low time lag it is important that the servomotor output be coupled sufficiently rigidly to the control surface which it actuates. With excessive resilience or springiness in the cables or other connecting means, the position of the control surface will lag behind the desired position called for by the input signal. The inertia of all moving parts must obviously be kept low in order to obtain quick response. There is a temptation in applying electric motors to such service to reduce over-all weight by the use of small high-speed motors with large gear reductions. It is important in such a case not to lose sight of the fact that the motor inertia effective at the output shaft of the gear train is the actual motor inertia times the square of the gear ratio. The important factor is the servo's torque-to-inertia ratio measured at the load, in this case, the hinge line of the airplane's control surface.

The principles just discussed have been embodied in the Sperry Type A-12 Gyropilot which is now being installed in new commercial aircraft for most of the major airlines. Directional reference is furnished by a Gyrosyn Compass, a directional gyro continuously slaved to the magnetic meridian, as

indicated by a remotely-mounted Flux Valve. A Selsyn on the Gyrosyn's vertical axis supplies to the rudder servo amplifier a signal proportional to the angular departure of the aircraft from the desired heading. Signals from this Selsyn also control an amplifier whose output energizes a number of repeater Selsyns to indicate heading at various stations in the airplane.

A second gyro with its spin axis slaved to the gravity vertical as indicated by a liquid level switch, furnishes the reference for stabilizing the airplane about its roll and pitch axes. Selsyns mounted on the longitudinal and transverse gimbal axes supply angular error signals to the aileron and elevator servo amplifiers respectively. All servo amplifiers are similar and are provided with adjustable electrical networks which permit combining the displacement and rate signals in the proper proportion. The sum of the error and derivative signals is amplified to energize the generator field of a Ward Leonard type servo system.

The reference attitude to which the airplane is controlled may be readily shifted by biasing the output of the Selsyn with a controllable series signal. Flight at constant barometric altitude is obtained by biasing the output of the pitch Selsyn with signal from a variable-reluctance type pick-off actuated by a barometric aneroid. This pick-off is mechanically clutched to the aneroid bellows at the desired altitude. The pick-off displacement and its output signal are then proportional to the departure from the reference altitude. With constant airspeed the rate of climb or descent is proportional to pitch attitude which in turn is proportional to the biasing signal supplied by the pick-off, and therefore to altitude error. Climb or descent may also be controlled by biasing signals from other sources such as a manually-operated voltage-dividing resistor or the output of an automatic approach glide path receiver.

The center of gravity of an airplane will shift in flight as fuel is consumed, passengers move about, or bombs are dropped. Lowering of gear and flaps and changes in engine power change the trim or hands-off attitude of the airplane. In manual flight these changes are compensated by manual adjustment of a trim tab at the trailing edge of the movable elevator surface. A standard component of the A-12 Gyropilot is a small servo which automatically moves the trim tab in a direction to reduce the torque output of the main elevator servo. When this output is zero, no force is being exerted on the elevator to maintain the reference attitude and the airplane is obviously trimmed for hands-off flight. Such a provision permits disengaging the Gyropilot at any time without fear of the airplane changing pitch attitude by reason of an out-of-trim condition.

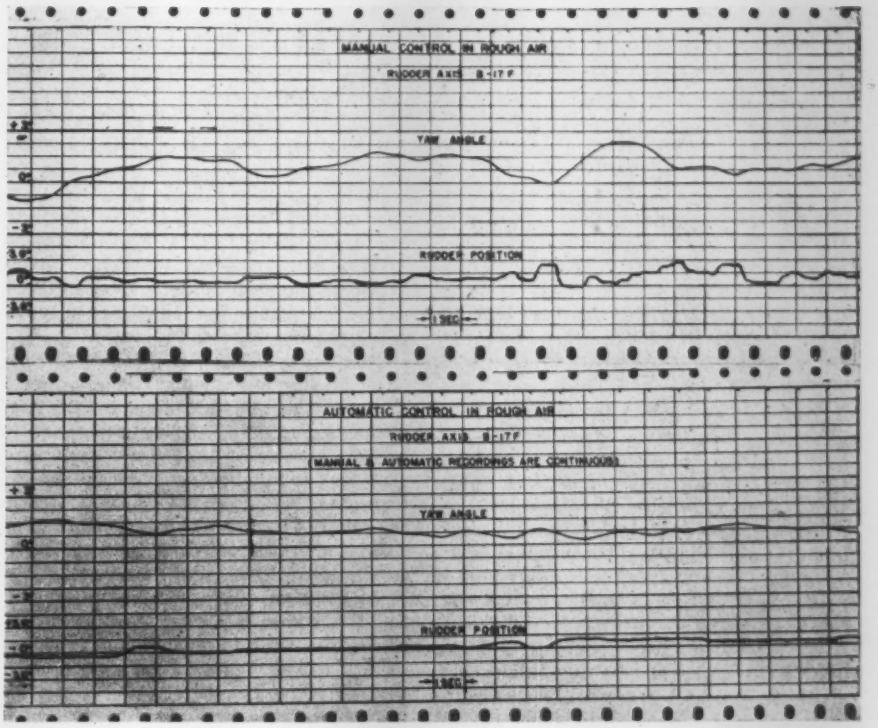


Fig. 3

The execution of properly coördinated turns requires that the bank angle and rate of turn be maintained in proper ratio as determined by true airspeed. In the A-12 Gyropilot a signal voltage which may originate in a manually-operated voltage-dividing resistor, or in an automatic approach localizer receiver or other appropriate equipment controls both bank angle and rate of turn. The rate of turn is established by the rotation of a motor-driven Selsyn differentially connected with the signal Selsyn of the Gyrosyn compass. Turn coördination for all airspeeds is achieved by modifying the turn Selsyn speed to maintain minimum sideslip as indicated by the average input to the rudder servo. Thus the same directional reference is used continually, both in straight flight and in turns.

Performance of this Gyropilot is shown in Figs. 1 and 3 which are reproductions of automatic recordings taken in flight. Fig. 1 shows the response to artificial transients induced by manually overpowering the rudder servo, then suddenly releasing it. The airplane is thus yawed off course manually and allowed to return under automatic control. The value of the time derivative or damping component of control moment is brought out in these recordings.

The upper portion of Fig. 3 is a recording taken during manual flight by a highly competent human pilot through turbulent air. The lower section shows flight performance immediately after the Gyropilot had been engaged. Air conditions were the same for both recordings. With automatic control the yaw errors are held to lower limits with much less rudder motion simply because the Gyropilot is quicker than the human pilot and applies corrective moments more accurately proportional to the airplane deviations. The improvement in riding comfort with Gyropilot control is considerable.

The performance of fully automatic approaches under bad weather conditions is no longer a dream but an established technique. Early this year at MacArthur Field, L. I., the Sperry Gyroscope Company demonstrated this technique using equipment which will shortly be in service on several of the major airlines. During the week of demonstration we were favored with several days of weather with ceilings varying from nearly zero to about 100 feet. All flight operations at LaGuardia and other nearby fields were halted. More than one hundred fully automatic approaches were made.

Automatic Approach is an example of automatic control, or stabilization, combined with automatic navigation. There is no reason why modifications of the same technique cannot be applied to other phases of flight such as beam following or automatic homing. It should not be inferred, however, that the airline pilot's day is about over. No automatic devices now in sight can replace his judgment, skill and training. The equipments which have been discussed in this paper are intended to relieve him of the heavy and tedious work of flying, and to leave him more time for his proper duties as commanding officer of the aircraft. They are intended to lend him a hand when necessary, but by no means to supersede him.

Training in Inspection and Gaging in Mechanical Engineering*

By ROGER L. GEER, Cornell University, Ithaca, N. Y.

MUCH has been written regarding the ingredients that constitute a balanced, comprehensive engineering course of study. Lately, we hear much of the humanities (and no doubt there are facts to substantiate this apparent need) in order to produce engineers adequately prepared to cope with our civilization.

The Society for the Promotion of Engineering Education, through its Committee on Engineering Education After the War, summarized essential objectives of an engineering curriculum as: First, mastery of the fundamental physical and mathematical laws and systems of measurement. Second, development of proficiency in the methods of engineering analysis, a comprehension of the related elements in a problem, and the ability to synthesize the various elements to obtain a practical and economical solution. Five additional items follow, all pertaining to the social and humanistic aspects of an education.

This paper outlines the origin and development of the course in Measuring Instruments for the Sibley School of Mechanical Engineering, Cornell University.

Analysis of the Mechanical Engineering curriculum at Cornell in 1939 revealed deficiencies in the courses on industrial processing. One of the omissions was instruction in the field of Measuring Instruments. It seemed proper then, to insert a course to study the standard tools and practices of shop measurement. Time would not permit a detailed treatment, nor was this intended, since the objective was not the training of skilled inspectors. The course served to complete the "processing" picture and provide the student with comprehensive and integrated knowledge about the production of commercial goods.

Shop courses (known as Mechanic Arts) took on a new dress, became known as elements in the Department of Materials Processing. The new "processing" courses consisted of one term of Metal-working (Hot and Cold working and Welding), and one term of Casting Processes (Pattern Shop and Foundry); these being given in the first year of the curriculum. Completion of these courses was necessary to register for Machine Tool Processes (two laboratory periods per week) and Measuring Instruments (one laboratory period per week). The instruction was separated into two courses to permit certain outside groups to take either part of the related instruction. Transfer students generally lacked the instruments instruction. In some instances, easier programming of student load could be arranged to take the instruments course after the machine shop.

The name "Measuring Instruments" is somewhat misleading since it implies a broad coverage—which is not the case. Measurements of time, temperature, speed, pressure, fluid flow, and hardness are not included in the course outline since they are adequately treated in other laboratory instruction. This course was restricted to *dimensional* inspection of commercial goods and gages.

At the time this course was being set up, Dr. Lynn Emerson was creating a series of four monographs on Inspection of Machined Parts, Tools, and Gages for the New York State Education Department. This work was completed in the Curriculum Laboratory at Cornell. The work was greatly implemented when the International Business Machines Corporation released their instructional material on "Precision Measurement in the Metal Working Industry" to serve as a reference textbook. This twelve-chapter volume became the basis for the Measuring Instruments course. As sources of technical material from manufacturers of measuring equipment became known, every effort was made to acquire additional information for the course. These teaching aids are mentioned in the outline of instructional units, later on in this paper.

Late in 1941, the Cornell Curriculum Laboratory participated in the organization of a series of related courses into a curriculum to accelerate the development of Junior Inspectors for Ordnance Materiel. This training program was taught at Cornell and other schools, and in other Ordnance districts throughout the United States under ESMWT sponsorship. While this was not a program suitable for Mechanical Engineering students, the inspection and gage laboratory elements of the curriculum could readily be adapted to the needs of the engineers. Meanwhile, the engineering students had been receiving instruction in the basic instruments of inspection and also the more complete picture of what constitutes the manufacturing of a completed article from raw material through final inspection.

The Ordnance Training Program ended February, 1943, after training more than 300 men and women. Since the war, we have contracted with the Rochester Ordnance District to maintain, in operating condition, a gage laboratory. Equipment left from the training program plus additions from plant excesses have provided us with an adequate laboratory.

The course contains 15 laboratory periods of 2½ hours duration. Demonstrations and discussions require about one hour of each period, the remainder being devoted to use of the equipment at the various inspection stations. Each student fills out an inspection report for the work he does. Some of the tasks, such as Surface Plate set-ups, are worked out on a team basis. During the term, six 20-minute quizzes are given. These examinations and the inspection reports constitute the student's term grade. Projects for the laboratory phase of the work have been selected from the Monographs on Inspection of Machined Parts, Tools, and Gages. From a total of 78 available, 37 have been selected to give practice in the operations of the instruments covered in the discussion sessions.

Care was exercised in the program of lesson topics, so that a logical and integrated sequence resulted.

The first meeting points out that the aim of the course is not to produce skilled operators but to develop understanding and appreciation of the instruments used in dimensional control. The importance of inspection to engineers is stressed. The Design of Development departments in industry must be aware of the latest shop techniques and standards for finishing parts; management must appreciate the functions of inspection as related to quality control and plant layout; research must be hunting for improved processes and new goods, often found to create new inspection tools since existing types are inadequate; and sales must have an understanding of quality in order to sincerely market their merchandise. The administration of the course must be explained, and the need for care in handling and reading ALL instruments. A brief history of Measurement from the time of the Pyramids up to the present provides splendid background material. This is generally the first realization by the student that *precision and interchangeability are NOT 20th century phenomena.* Since most people think of inspection as a "length, breadth or depth examination," dimensions of Form, Alignment, and Size are defined and illustrated.

The degree of control in approaching perfection in measurement has separated tools into three groups, namely, non-precision, precision and super-precision, the latter having disputable boundaries. Non-precision equipment generally consists of those tools that permit control to fractions of our main dimensional unit: 1/64" in lineal units. These tools are the scales and their

*Presented at the first Annual Conference of the Instrument Society of America, William Penn Hotel, Pittsburgh, Penna., Sept. 16-20, 1946.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

many attachments, including the combination set, calipers, dividers, trammels, and the surface gage. The construction and proper use of these are demonstrated, followed by the student practice with these instruments at the inspection benches.

The second period covers the elementary precision instruments. The creation of the basic Form (the Surface Plate) by the technique of Whitworth is carefully outlined. The *origination* of alignment standards such as angle plates, once a flat reference surface is available, is discussed in detail. The story of Johansson Gage Blocks as master Size standards is included along with the development of the Hoke Blocks. The many varieties of these fundamental tools are demonstrated and their proper usage shown through the use of films and actual set-ups. These include the many kinds of squares, parallels, and V-blocks, as well as the three qualities of gage blocks.

Students are informed regarding the relative accuracies and cost of these tools, in order that full appreciation of their precision may be realized.

Micrometers and Verniers are studied during the third meeting. The original scheme and the development of the micrometer to its present state are discussed to justify the presence of each element in the construction as essential to proper functioning. Common commercial parts are used to demonstrate the application of outside, depth, screw-thread and special micrometers. The need for special anvils and spindle tips is pointed out in such measurements as wall thickness of tubing, resilient materials, narrow grooves in form tools, and abrasive surfaces. The handling of large micrometers is explained, and the need for consistency in feel to get reliable readings is stressed. The principle of vernier scales is explained, and their application to calipers demonstrated. The relative merits of the micrometer and vernier caliper are compared with stress on the need for care in the amount of pressure on the contacting members. Laboratory use of these instruments quickly reveals variations in readings on the same parts. The accepted accuracies of these instruments is revealed, and caution is urged in the use of micrometers with tenth verniers.

Having covered the tools commonly used to obtain direct values of dimensions, we proceed in the fourth lesson to discuss Fixed Gages. Considerable background material is necessary before the use of any type of gage can be understood. First, review of standard dimensioning practices, metal-to-metal fits, and a clear understanding of such terms as basic size, allowance, tolerance, and limiting sizes are required. Discussion of the principles of gage manufacture, gagemaker's tolerance, and wear allowance is essential before examining the many styles and types necessary to inspect commercial goods. The range of gages should include plug, ring, and snap gages for checking round, square, and splined components; tapers; threads; radius and fillet, and special templets. Flush pin type gages are also demonstrated, not only to check size, but also form and alignment. Laboratory exercises permit each student to practice with each type of fixed gage.

The previous laboratory sessions convinced the student that some control over measuring pressure is mandatory for reliable and consistent inspection reports. The use of ratchet stops on micrometers leave much to be desired; the drag on a feeler gage or cellophane strip is far from satisfying in many instances. This situation paves the way to a study of Test Indicators and Dial Gages. The construction of simple amplifying devices such as the wiggler is demonstrated, followed by the features of the test indicator and then the dial gage. Construction standards set up by the American Gage Design Committee are explained, and the many patterns are exhibited. The applications of these many types are demonstrated, first as contact pressure indicators when attached to other devices, such as the vernier height gage, and second, as comparator type instruments. Parts measured on the micrometer and vernier caliper are now re-measured using indicators, and the results compared with previous readings.

The sixth period is devoted to the technique of angular measurement. Protractors of the combination set type, bevel, and vernier bevel are demonstrated, with review in reading angular verniers. The sine bar is so important in shop layout and inspection work that considerable time is spent in demonstrating its applications. Sine plates and fixtures are also shown. Then the construction and use of the indexing heads: simple, universal, differential, K&T Astronomical, and Vinco are explained. Universal angle gages and angle gage blocks are described, and their applications demonstrated. The solution of tapers and other angular relationships by using steel spheres or cylinders with standard end measuring tools is explained.

Comparators comprise such a varied assemblage of instruments that three periods are needed to cover the more common types. The trend toward comparator techniques in making practically all measurements beyond tenths of thousandths demands serious attention to this group of equipment. The mention of commercial brands seems unavoidable in order to specify types. Students should be familiar with Sheffield Reed mechanism—with the light beam and also the electric head, Pratt & Whitney Electrolimit, J & H Electronic, Federal Electronic, with either lights or sound tones (for the blind). Instruments using fluids, both liquids and air, as measuring media are carefully explained, especially the pneumatic comparators that have been so popular in recent months. The Sheffield, Federal, Moore, and Pratt & Whitney types are clearly differentiated as to working principles and each is compared with other instruments of like range and sensitivity, by laboratory demonstrations to reveal their relative merits.

Projection comparators fill the need for inspection tools to examine the many peculiar shaped articles found in everyday merchandise. These items, often lacking symmetry, are of such peculiar shape and minute size, they prohibit inspection by any other means. Their use to check thread plug gages, form cutting tools, tiny instrument parts, and (by reflection) type faces and printing stamps are demonstrated. Their operating principles and applications are covered in detail, especially the use of the attachments for reflected image inspection.

In a course limited to one laboratory period per week for one term, little time is available for explanation of the operations and applications of that group called Measuring Machines. These devices should be known to the student, and brief demonstrations performed on the Supermicrometer, the Standard Measuring Machine, The Toolmaker's Microscope, the Optical Flat with Monochromatic Light and Surface Roughness measuring equipment—the Profilometer, the Brush Surface Analyzer, and the General Electric (and other) sample plates are adequate. This array of demonstrations takes an entire laboratory period, and is well worth the time expended.

The eleventh period is devoted to a study of the procedures for Thread and Gear inspection. Time is taken to review the functions of threads, the standard thread profiles, and their significant dimensional elements. A clear conception of the terms *lead*, *pitch*, and *pitch diameter* is necessary for understanding the procedures in thread inspection and the manner of using gages for checking, especially fixed type gages. The three-wire scheme for pitch diameter measurement is derived and the actual measurement demonstrated on a Supermicrometer. The use of projection comparators for thread inspection is re-emphasized. If time permitted, the inspection of gears would be taken up at a separate meeting, since duplication of terms may lead to confusion. Careful instruction provides an excellent opportunity to clear up these unfortunate duplications. The inspection of gears involves an examination not only of each tooth profile, but also its arrangement with all the others that comprise the gear. Since gears are not solo instruments, but always work in pairs or systems, accumulated errors are critical. The gear-making industry has developed special inspection devices for investigating the tooth profile, run-out, pitch, noise, and angular relationships in the cases of bevel, spiral and hypoid gearing. It is beyond the hope of most school

laboratories to acquire all of these devices, and here is an instance where movies such as those by Fellows Gear Shaper Company are invaluable.

The entire array of standard as well as some special measuring instruments have now been described and demonstrated to the class. The material from these lessons can now be applied during two periods devoted to layout and inspection problems. These problems require the student to organize his procedure and list the equipment needed. Completion of this phase of the problem permits the student to select and set up the equipment, and proceed with the inspection report. Interpretation of working drawings is important, and this series of problems—most of them involving surface-plate set-ups, emphasize the need for care in the interpretation of dimensions and notes. The problems serve also as a review in the techniques in handling not only the surface plates and their accessories, but also micrometers, verniers, test indicators, angle measuring devices, gage blocks.

One can always be skeptical, and wonder who checks up on the "checker-upper." One period devoted to demonstrations of typical gage checking acquaints the student with this aspect of the "behind-the-scenes" operations in an inspection department. Since extreme care is necessary in gage inspection, one laboratory period is devoted to the demonstration of checking gage blocks (a Working block against an Inspection block of same size); Thread Plug Gages by use of a Supermicrometer and Projection Comparator; a Drill Jig using Precision Plugs and Gage Blocks; Taper Plug Gages by means of a Sine Plate and Electrolimit Comparator, and a Surface Plate and Vernier Height Gage with Test Indicator and Gage Blocks. Setting and checking of adjustable snap gages is demonstrated.

The final session of the term is devoted to the inspection of Machine Tools. While this cluster of information is a phase of inspection operations, its presence is desired primarily to acquaint the student with the capabilities and limitations of performance of those machines that produce the bulk of our commercial goods. The American Standards Association recommendations for engine lathes are examined in detail, followed by excerpts from Dr. George Schlesinger's treatise on Testing Machine Tools. Time does not permit complete study of this writing, hence the discussion is limited to the production type tools. Displays of the Inspection sheets use by Hendey Lathe, Nichols Miller, and Defiance Boring Machine help add realism to this discussion.

Enough time is set aside to permit each student to clean and pack away some piece of laboratory equipment during the last laboratory period.

The equipment required to set up a laboratory for this course is listed in the Organization Monograph of the series mentioned. While this proposed list was designed for handling classes where skills were stressed, the data are applicable to engineering student classes. The total cost is about twenty thousand dollars, complete with air conditioning and furniture.

Many visual aids are available for assisting in the presentation of the course. Eastman Kodak and U. S. Office of Education films are very helpful, especially the review strip films for follow-up after the sound movie. Commercial strip films are extremely well made, although some are too advertisy. Of particular merit are Jones & Lamson's film on "Projection Comparator" and DoAll's films on "Gage Blocks." The color movies by Federal Products on "Dial Gages," and Fellows Gear Shaper's on "Gear Inspection" are exceptionally good. The main objection to movies is the inability to flash back certain important shots—overcome by some individual slides made from the movie frames or from still shots. Wall charts, such as Starrett's "Small Tools," Sheffield's "Dimensional Control" and Brown & Sharpe's "Micrometer and Vernier Details" are most helpful.

Although we have built and used home-made models and mock-ups to demonstrate the principle of vernier scales, the reed mechanism, light lever and light-wave interference, the use of good free-hand blackboard sketches must be emphasized. The sketch method of presentation requires some skill on the part of the instructor, but it provides a means of building up a sequence of the elements into a total picture that should be readily comprehended.

Many manufacturers present much valuable information in their catalogs. Brown & Sharpe, Taft-Pierce, Van Keuren, Starrett, Sheffield, Pratt & Whitney, DoAll and Federal Products are among those who generously provide instructional material. The textbooks from which the course was organized include the two volumes of "Precision Measurement in the Metal Working Industry" by International Business Machines Corporation; "Industrial Inspection Methods" by Michelon, "Essentials of Precision Inspection" by Mollard, "Fundamentals of Mechanical Inspection" by Jenkins, "Methods of Machine Shop Work" by Halsey, "A History of Engineering" by Fleming & Brocklehurst, and "Testing Machine Tools" by Schlesinger. Much valuable information has been gleaned from American Standards Association and Ordnance Manuals.

Some colleges, including Cornell, have recently developed a 5-year curriculum for their mechanical engineers. Cornell has increased the time allowed for shop instruction so that it is now possible to discuss the basic measuring tools (scales, calipers, dividers, surface gages, surface plates, and their accessories, gage blocks, verniers, micrometers, angle measurement, and the transit and level) during the first year. This is necessary if the instruction in Measuring Instruments is to assist in the effectiveness of other courses of instruction. Some ability in using tools is required in laboratory work in physics as well as the elementary shop practices.

In the sixth term, mass production techniques and machinery are studied, simultaneously with work in the Gage Laboratory. The Gage Laboratory work covers fifteen periods of study in inspection. In addition to the administrative and organization aspects of industrial inspection, this course will provide instruction on all types of comparators, gages, and measuring machines. Gage checking, surface finish measurement, machine tool inspection, and the use of surface plate equipment for examining sample parts and proving layouts will be emphasized. Stations will be organized to provide practice in gathering quality control data along with motion and time studies. Demonstrations on non-dimensional inspections, such as color matching, surface imperfections and the like, will be provided.

The new curriculum provides for a project to be carried out in some field during their last year at school. We have had a few enterprising and ambitious students elect this sort of task under the present program.

The problems incident to producing of a mechanism after conception by one individual so that it functions as intended has made the Measuring Instruments Laboratory a popular area for tracking down the bugs in the students' mechanical endeavors. It has been inspiring to note the curiosity on the part of many veterans regarding the manner of making their fighting implements so precisely, yet in enormous quantities.

Industrial operators, formerly awed by 0.001″ tolerances, are now nonchalantly accepting 0.0001″ limits. The ability to produce to close limits has been chiefly in machining processes, along with such refined techniques as superfinishing, microhoning, and precision broaching. Equally noteworthy are the less publicized developments of forgings to 0.005″, intricate castings to 0.001″ and localized heat treatments on specific areas to precise limits of depth and hardness.

The past war has made us all "control conscious." Engineers and production men are accustomed to extracting the utmost precision from the standard operations of shop manufacturing. This habit is carried over into the newer techniques as they are adopted. Note that many of the new schemes are processes of the *preliminary* variety—where maintenance of precision should be consistent with the remainder of the processing.

The Mechanical Engineering curriculum that includes a study of Inspection and Gaging will certainly enhance the full training of the student in Industrial Operation. Those who do not receive this training at college will need to learn it the hard way.

INSTRUMENTS ON THE MARCH

Timing Instruments for Record-breaking Jet Planes

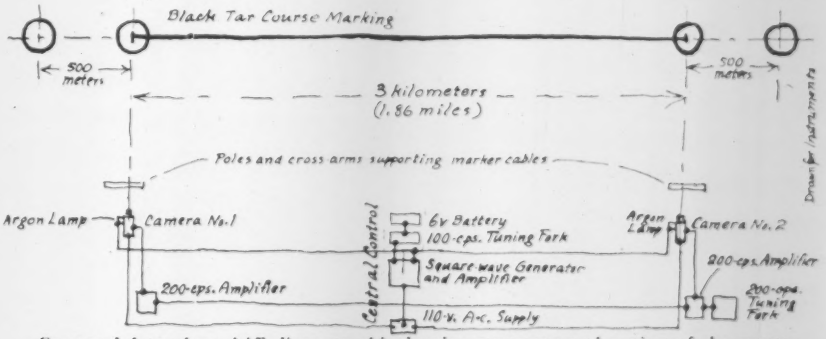
By ROBERT KING*

MUROC, Calif.—Outwardly, the AAF's speed tests conducted at Rodgers Dry Lake, Muroc, Calif., are spectacular but simple. A dot, trailing a ribbon of black smoke, zooms downward in the distance to less than 300-foot altitude, widens into the outline of a speeding aircraft and streaks across a measured course to close up into a dot in the distance. After a lapse of a few minutes, the performance is repeated in the opposite direction. Behind the spectacular aspect of the speed runs, considerable precision is involved in the speed determinations. This discussion of the timing method shall concern itself with the two contributing factors in the accuracy of aircraft speed measurements: (1) the accuracy of course length and alignment and (2) the precision and accuracy of the timing devices themselves.

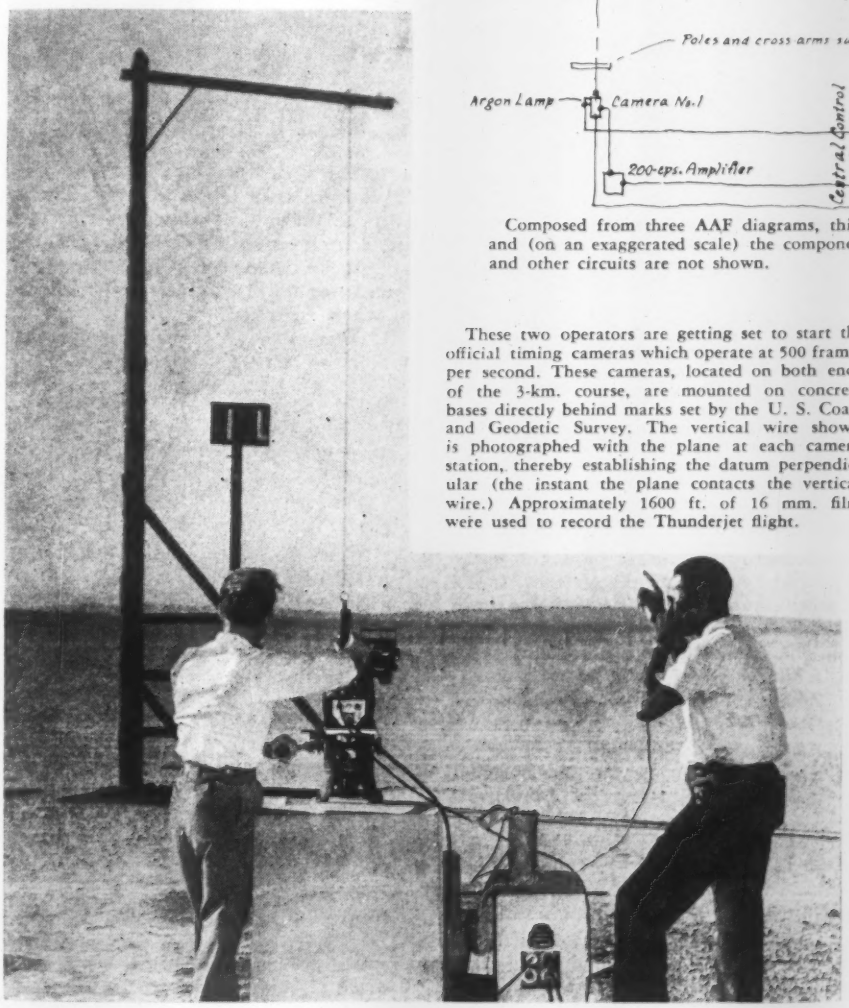
*The author of this special AAF release is a civilian Physicist in the Photographic Division, Air Matériel Command, at Wright Field. During the runs, Dr. King operates one of the timing cameras. He later assists in analyzing the film. Development and analysis of the timing film require approximately 24 hours.

Accuracy of Course Length and Alignment

The 3-kilometer speed course distance was surveyed by the United States Coast and Geodetic Survey to an accuracy of one part in 600,000, each end of the course being indicated by bench marks set in concrete. Concrete bases three feet high and three inches behind these bench marks were constructed for use as rigid high-speed motion-picture camera mounts. On these bases, camera mounting bolts were located with a transit and set in the concrete so as to facilitate the very small final adjustment. By dropping a plumb bob, the centers of the camera lenses were set directly over the United States Coast and Geodetic Survey markers. Vertical ¼" diameter cables (vertical to within 20 seconds of arc) were aligned by transit with the camera-lens centers at each end of the speed course and placed under 100 pounds of tensile stress. The cables, placed 35 feet in front of each camera station and supported by a post with side arms, were accurately set by surveyors and were checked for alignment before each record run. Thus, camera-lens centers and vertical cables formed perpendicular datum planes at each end of the three-kilometer course for photographically recording by high-speed motion-picture camera the speeding airplane at the exact beginning and exact end of each pass over the course. The actual flight path of the plane, however, is some 700 feet out beyond the camera stations, parallel to a line joining the camera-lens centers.



Composed from three AAF diagrams, this drawing represents a plan view of the course and (on an exaggerated scale) the components of the timing instrumentation. The intercom and other circuits are not shown.



These two operators are getting set to start the official timing cameras which operate at 500 frames per second. These cameras, located on both ends of the 3-km. course, are mounted on concrete bases directly behind marks set by the U. S. Coast and Geodetic Survey. The vertical wire shown is photographed with the plane at each camera station, thereby establishing the datum perpendicular (the instant the plane contacts the vertical wire.) Approximately 1600 ft. of 16 mm. film were used to record the Thunderjet flight.

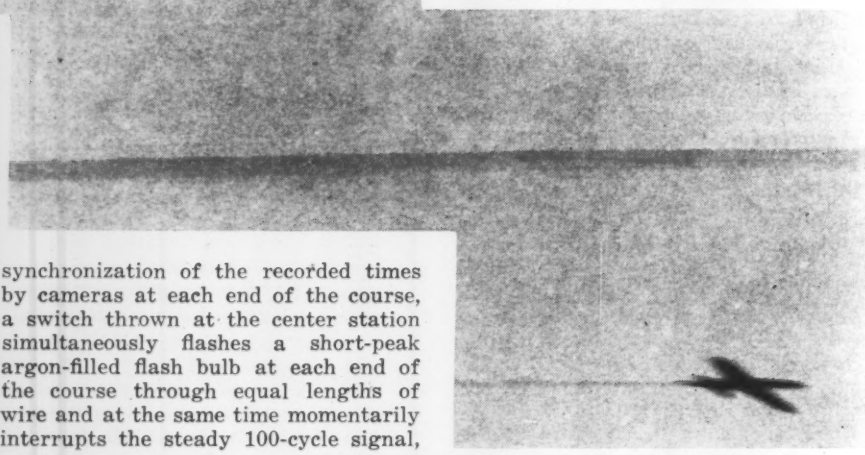
Precision of Timing Devices

In the actual timing of the speed runs, modern photographic and other instrumentation form a well-coördinated precision team. Electric Research Products Inc. high-speed motion-picture cameras, winding 16-mm. film through at the rate of 500 exposures per second, record in relatively infinitesimal steps the flight of the speeding plane as it cuts the datum plane at each end of the course. At this frame exposure frequency, the actual position in space of aircraft traveling up to 650 mph. may be determined photographically to ±0.25 foot of its transition at the ends of the course. 100- and 200-cycle tuning forks, calibrated by the National Bureau of Standards at Washington, and square-wave generators form the amplified frequency standard or precision "heart-beat" of the timing system. The 100-cycle-fork frequency standard, used as the basis for the impression of a uniformly-timed series of light streaks

This remarkable photograph was taken by AAF photographer Chief Warrant Officer Stephen Mengelluzo with a K-20 aerial camera, through the escape hatch of a C-47 hovering in the vicinity of the course. The XP-84 Thunderjet was being flown by Captain Martin L. Smith directly over the 12-foot-wide black tarred surface which marks the 3-km. course. Capt. Smith was flying at an altitude of less than 246 feet.

Paced by its own shadow, XP-84 Thunderjet streaks over black tar guide strip

ARMY AIR FORCES PHOTO



on the edge of the motion picture film racing through the camera during the speed runs, is the primary timing standard and is guaranteed by the Bureau of Standards to give 100 cps. to an accuracy of better than one part in 500,000 over the operating temperature range. A secondary timing standard is a system of synchromotor clocks mounted on the base of each high-speed motion picture camera so as to be photographed on each exposed frame of motion pictures. Five-second checks of these 0.001-second interval reading clocks are obtained against the film recorded pulses actuated by the calibrated 100-cycle tuning fork. To effect synchronization of the recorded times by cameras at each end of the course, a switch thrown at the center station simultaneously flashes a short-peak argon-filled flash bulb at each end of the course through equal lengths of wire and at the same time momentarily interrupts the steady 100-cycle signal, causing an integral number of light streaks to be omitted on matching films from the two cameras. In determining the time of aircraft passage over the speed course, the built-in camera clocks, having been calibrated by the 100-cycle pulse record, are used directly to read the time. The time lapse between the plane passage of the vertical cable and the break in the regular beat of the 100-cycle frequency standard is noted on each film from opposite ends of the course for the same pass and the two times added to get the total time. By simple arithmetic, the average speed of the aircraft passage may be calculated from the time of passage.

Automatic Airport Approach for Entire UAL Fleet

CHICAGO. — Following commercial aviation's first demonstration of the new Sperry electrical Gyropilot incorporating automatic airport approach controls, United Air Lines has announced that it is proceeding to equip its entire fleet with these devices.

As the first airline to test the new automatic flight procedure, United conducted its successful demonstration September 11 at MacArthur Field, Long Island, N. Y. Fig. 1 shows the glide path transmitter and Fig. 2 shows the localizer transmitter bringing in a United Mainliner precisely to a point above the end of the landing runway.

Fig. 1

Conversion of United's fleet of four-engined Mainliner 230's (C-54's) to accommodate the new instruments already has begun at the company's Cheyenne maintenance base and is expected to be completed by April, 1947. Similar equipment is to be standard on United's four-engined Mainliner 300's (DC-6's) and new type high-speed Mainliner 303's (Martin 303's).

Engineers describe the new Gyropilot as a completely electrical and electronic installation, designed to replace the hydraulic automatic pilot currently employed by the nation's airlines. It incorporates such revolutionary features as the Gyrosyn Compass directional control, constant-altitude control and automatic operation of the aircraft's elevator trim tab. This last-named feature is essential for a perfected automatic airport approach technique.

The altitude of the plane is controlled by two electrically-driven Gyroscopes rigidly mounted in the plane. One, the vertical control, is for movement of elevators and ailerons. The other, the Gyrosyn compass control, actuates the rudder.

The plane's three control surfaces are operated by electric motors geared to a cable drum. Cables from the drum run to the control surface horns to keep the plane in trim longitudinally. There also is an automatic elevator trim tab control. A lever on the cockpit pedestal disengages these controls to permit manual use of the plane's control system when desired.

In emphasizing the significance of the new devices, W. A. Patterson, president of United, indicated that his com-

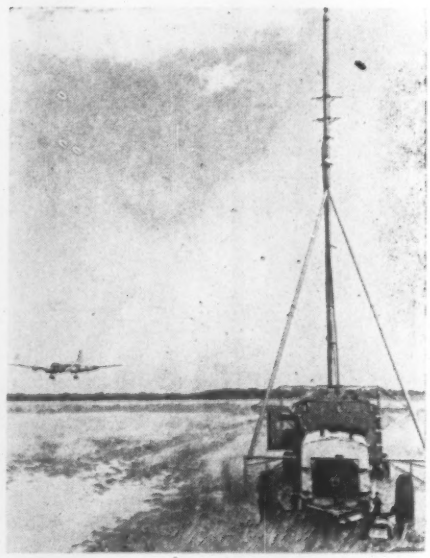


Fig. 2

pany will be ready to employ the new equipment in regularly-scheduled operations by the winter of 1947. He pointed out, however, that much testing and flight personnel training must precede such use.

Mr. Patterson, who participated in the MacArthur Field demonstration, hailed the event as marking a first step in the direction of eliminating weather as an obstacle to airline operation, and, toward eventual complete regularity of schedules. P. R. Bassett, president of the Sperry Gyroscope Company, termed the demonstration "a milestone in air transportation history" and indicated that still further developments of automatic flight are on the way.

Meteors Detected by Radar

By ROSS BATEMAN[1], A. G. McNISH[2] and VICTOR C. PINEO[3]

WASHINGTON, D. C.—Scientists of the National Bureau of Standards are now using radar to investigate the ionization caused by meteors. Beginning the night of October 7 and continuing through October 12, reflections from the meteor shower associated with the Giacobini-Zinner comet were clearly visible on the oscilloscope screens of the radar set. (Fig. 1) The investigations, which are to be continued by the Central Radio Propagation Laboratory of the Bureau of Standards, are expected to indicate the effect of meteors on radio waves, particularly important in FM broadcasting and long-range radio communication and navigation. Moreover, the technique is significant in astronomy as a method of observation on overcast nights and during the day when meteors are not visible.

Signals were observed on both the A and PPI oscilloscopes of the radar set. A photographic record was kept of the PPI indications (example, Fig. 2) while the A scope was monitored by an operator who kept a log of the time, range, and approximate duration of the reflections. The peak of the meteor shower was expected on the evening of October 9. The rate of occurrence rose from approximately 8 per hour between 7:30 and 8:30 to a peak of over one per minute between 10:30 and 11:00, coinciding approximately with the predicted time of 10:00 for the maximum intensity of the Draconid shower. Following this maximum, the rate fell to about 20 per hour after 11:15. Distances ranged from about 60 to 200 miles. Duration of the transient radar reflections was usually one second or less, although a considerable number lasted for several seconds. Only a few appeared to change distance during the time that they could be observed on the screen, and change was of the order of five miles or less. (See Fig. 3.)

The radar used in these investigations is the standard Signal Corps Type SCR-270-D, operating at about 107 Mc. and transmitting 25-microsecond pulses at a repetition rate of 400 per second, with a peak power of approximately 100 kw. The antenna (Fig. 4) was oriented at an azimuth of 315° and an elevation of 45°. The width of the main beam of the radar antenna, consisting of 32 dipoles arranged in a rectangular array, was approximately 40° × 20° between half-power points, the major axis being vertical.

Although meteors weighing several

[1]Chief of Experimental Ionospheric Research Section.

[2]Chief of Basic Ionospheric Research Section of NBS Central Radio Propagation Laboratory.

[3]Radio Engineer in charge of Bureau's Radio Propagation Laboratory at Sterling, Va. and in direct charge of "Project Meteor."

Fig. 1. Receiver console of the SCR-270-D radar set used by the NBS to detect meteors. At the right is the A scope; components of the camera unit used to photograph the meteor reflections cover the PPI scope at the left.

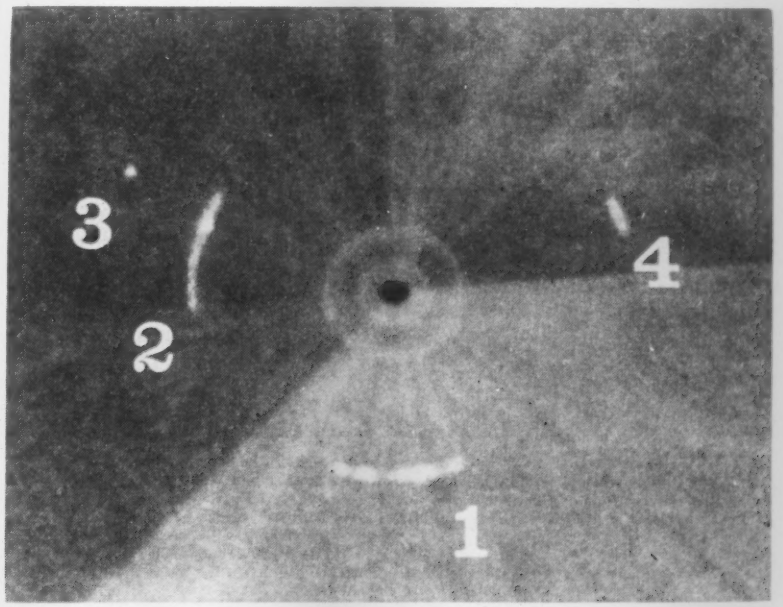


Fig. 2. Four meteor echoes appearing on the PPI radar screen on the night of October 9, 1946, during observations by NBS scientists. Trace (1) indicates an approximate range of 75 miles and an echo duration of 15 seconds; (2) range 75 miles, duration 13 seconds; (3) range 100 miles, duration ⅕ second; (4) range 85 miles, duration 3⅖ seconds.

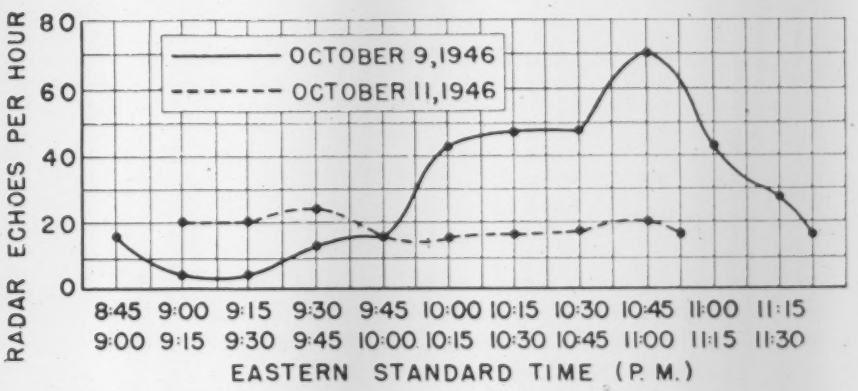


Fig. 3. Rate of occurrence of echoes on the nights of October 9 and 11, 1946, as observed by NBS scientists using the Signal Corps type SCR-270-D radar set. Astronomers had predicted the maximum hourly rate of occurrence of the Draconids for the night of October 9.

tons occasionally strike the earth, the solid matter in most visible meteors weighs only a few thousandths of a gram. The frictional heat generated by their high rate of travel through the atmosphere is sufficient to vaporize the solid matter and produce a trail of hot ionized gas in the neighborhood of the meteor. It is this trail of hot gases which produces the visible glow. These gases and the adjacent atmosphere at the time of passage of the meteor are apparently highly ionized.

Ionospheric investigations have shown that ionized gases will reflect radio waves below a given frequency, allowing higher frequency waves to pass through. The frequency that will just be reflected by a region of ionized gases is proportional to the square of the density of ions. Owing to the amount of frictional energy dissipated by a meteor, the hot gases in its trail should be ionized for a brief instant to a much greater extent than is the ionosphere. It is known that the 100 Mc. radar waves are able to penetrate the ionosphere. However, the ionization in the trails of meteors should be sufficiently intense to reflect radio waves at least in the region of 100 Mc.—a frequency relatively low in terms of modern radar but much higher than the frequencies used for long-distance sky-wave radio communication.

Supporting evidence for these contentions was the fact that interference encountered on the old FM broadcasting frequencies in the form of "bursts" (parts of programs from long-distance stations interfering with local station performance) had been found to coincide with the appearance of meteors. Further, it had been reported that during the war radar operators tracking V2 rockets had been confused by reflections from meteors. Other radar observers such as O. P. Farrell, working in an unofficial capacity in India, had made observations which coincided with the visual observations of meteors.

Simultaneously with the work of the National Bureau of Standards, observations were conducted independently by the Signal Corps in New Jersey, using radars on 600 and 1000 Mc., but with no results. These negative findings were as valuable as the positive findings elsewhere, because they indicated that the ionization density reached in these meteors is such that the upper limiting frequency which they could reflect is between 100 and 600 Mc.

One way in which meteors may affect radio waves is to cause the "bursts" on FM channels. Some scientists, such as Prof. J. A. Pierce of Cruft Laboratory, Harvard University, believe that a large part of the ionization of the E layer of the ionosphere may be caused by meteors. A knowledge of the behavior of the E layer is of primary importance since it controls radio propagation on many of the frequencies used for radio communication and radio navigation. Out of the research on the effect of such phenomena will come decisions as to which frequencies are the best for the various types of radio services. These recent tests, together with the observations made on the moon, indicate that radar, beside being a plane locator and navigation device, is a valuable tool for the study of radio wave propagation and, again, is fast finding its place in the field of astronomy.

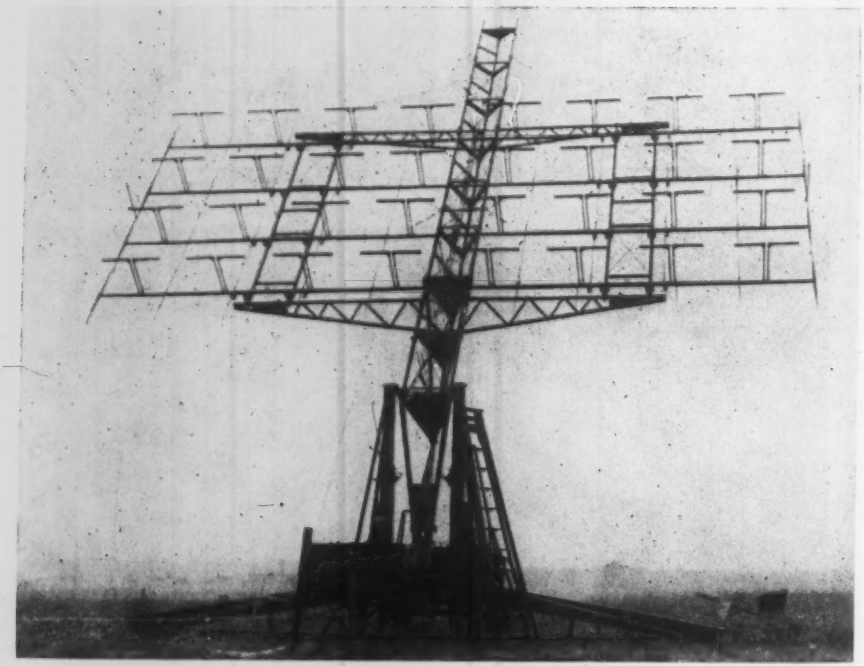


Fig. 4. The antenna of the SCR-270-D, consisting of 32 dipoles arranged in a rectangular array, was oriented at an azimuth of 315° (clockwise from North) and an elevation of 45° during the observations of the meteor shower. The width of the main beam is approximately 40°×20° between half-power points, the major axis being vertical.

New Indicator Detects 0.000,000,2 % CO

WASHINGTON, D. C.—A colorimetric indicating gel that will detect and estimate less than one part of carbon monoxide in 500 million parts of air—a sensitivity more than 100 times greater than attained by former chemical indicators—has been announced by the Gas Chemistry Section of the National Bureau of Standards. This gel will also determine physiologically significant amounts in approximately one minute at ground level. The indicator is so sensitive that it is possible to diagnose CO poisoning by analyzing exhaled air instead of taking a blood sample. Developed to meet the wartime demand for a simple and sensitive means for determination of very small amounts of CO in military equipment and installations, it offers promise for many peace-time applications.

Early in the war it was evident that the determination of physiologically significant amounts of CO in aircraft, particularly at high altitudes, would assume increasing importance. This was true as well with such equipment as flame throwers, tanks, gun pits and turrets, PT boats, landing craft and aircraft carriers.

Existing methods of determining CO possessed two decided disadvantages. First, the simple, inexpensive, easily-available methods were not sufficiently sensitive. Second, those which were sufficiently sensitive were unsuited for field use, with the exception of one expensive instrument, available in limited quantities, whose operation and maintenance were generally beyond the abilities of non-technical men in the services.

During 1941 the Royal Aircraft Establishment, Farnborough, England, had developed an indicator for the detection and estimation of small amounts of CO on board aircraft. As this indicator was not entirely satisfactory, the Bureau of Aeronautics, Navy Department, and later the U. S. Army Air Forces requested the National Bureau of Standards to study the RAE gel, with the object of improving it or developing a suitable substitute. Starting with this material Bureau chemists produced an indicator about four times as sensitive, more adaptable to field conditions and truly colorimetric.

The indicating material, yellow in color, is a silica gel impregnated with a complex silico-molybdate compound and catalyzed by means of palladium in the form of the sulphate. The yellow indicator turns various shades of green and bluish-green on exposure to very low concentrations of CO. The color response is a function of time by concentration of CO—a direct parallel to the physiological response to this gas. For use, the indicator gel is sealed in a small glass, 5" long and the diameter of a lead pencil, with protecting layers

of pure silica gel in each end of the tube.

To make a test, the ends of the indicating tube are broken off and the tube inserted in an ordinary 2-oz. rubber aspirator bulb equipped with a special rate-controlling valve. The air to be tested is drawn through the tube by squeezing the bulb once and any color that develops is compared with a set of standard color chips. Such a test can be made by untrained personnel in about one minute. For use in aircraft, tables giving correction factors for altitude are provided. Complete equipment for field use can be carried in a box which fits the pocket of a field jacket.

The NBS Colorimetric Carbon Monoxide Indicators were made only at the National Bureau of Standards. More than a half million were supplied for the military services of the United States, Canada and Great Britain. Patents have been issued on the device and assigned to the Secretary of Commerce.

Among the prospective peace-time uses are examination of air in and around busses, automobiles, garages, furnaces and furnace rooms, industrial plants, and civilian transport planes; and in the diagnosis of carbon monoxide poisoning. The tubes may also be modified to serve as detectors of other reducing gases and vapors, including many organic vapors.

Guided-missile Research Features Ionosphere Instruments

SCHENECTADY, N. Y.—Rockets that will surpass the German V-2 in speed, distance, accuracy, and effectiveness are objectives of a program of guided-missile research being conducted jointly by General Electric and the Army Ordnance Department, according to an announcement by R. S. Neblett, Manager of G-E's Federal and Marine Divisions.

"The research program was started in November, 1944," he said. "G. E. scientists were sent to Europe to study captured V-2 rockets, prior to V-E Day. Special facilities have been provided by the Army at the Company's Schenectady Works for testing new types of rockets and motors. Meanwhile, Company scientists and officials have been assisting with test firings of the V-2 rockets at the Army Ordnance Proving Grounds, White Sands, N. M."

Mr. Neblett disclosed that power propulsion research is along the lines of rocket engines, ram-jets, and a combination of both. For determining the nature of the upper air, special instruments weighing as much as 1800 lbs. replace the war head. These instruments, through radio impulses, relay to the ground temperatures, pressures, cosmic rays, spectrograph studies, and other data. By forcible ejection from the body of the missile, delicate recording instruments bearing invaluable data can be parachuted to the ground undamaged.

Previously, such information was limited to the ceiling altitude of the free balloon, 21 miles. Now, the rocket-propelled missile pierces the ionosphere over 100 miles above the earth.

"Polanret" Microscopy

NEW YORK CITY.—A new microscopical method which makes the details of living cells and other transparent materials visible was described at the thirty-first annual meeting of the Optical Society of America by Harold Osterberg of the Scientific Instrument Division of the American Optical Co. It uses polarized light and is called "Polanret" microscopy.

"Up to the present, phase microscopy* has required several diffraction plates for examination of a wide selection of materials and for control of optical contrast," said Dr. Osterberg. "This was costly, inconvenient and time consuming. With Polanret microscopy these changes can be made smoothly and continuously simply by rotating two knobs until the observer sees the most satisfactory image.

"It places at the disposal of the observer the equivalent of infinite number of difference plates combined in one convenient, general-purpose instrument.

"Polanret microscopy differs from phase microscopy in the fundamental respect that differences in optical path and light transmission are introduced by means of polarizing materials rather than by the direct method of introducing a diffraction plate to absorb or increase the optical path of certain portions of the light beam which passes through the microscopic objective."

*For an illustrated description of the latest phase-microscopy equipment see "Phase Microscopy," *Instruments*, Sept. 1946, page 527.—Ed.

The Icaroscope

NEW YORK CITY.—The lid has been lifted on one of the United States Navy's most important air defense secrets, the Icaroscope, a device which enabled pilots to spot an enemy airplane speeding toward them directly in line with the sun. Dr. Brian O'Brien* professor of optics and physics at the University of Rochester, described the telescope-like device to more than 700 fellow-members of the Optical Society of America.

The Icaroscope (named after the Greek mythological Icarus who flew so close to the sun that the wax which held his wings melted) takes advantage of what is known as afterglow in a phosphor screen. A phosphor is a substance which stores up energy when excited by radiation of short wave-lengths or high-energy particles. In the Icaroscope as used by Navy pilots it soaked up sunlight.

The image, such as an enemy plane in bright sunlight, is formed on a transparent phosphor screen while the screen is hidden from the eye. A double rotating shutter then closes off outside light and the pilot sees the image 1/100 second later. By this time the brilliance of the sunlight on the phosphor screen is only 20 to 50 times that of the surrounding sky as compared with the sun's real brightness which is 10,000 to 100,000 times that of the surrounding sky. The result is that a plane can be seen on the screen silhouetted against the sun's disk or the surrounding sky.

The disks are rotated by an electric motor at about 100 cps. so that the viewing appears to be continuous as in a high-speed motion picture camera. The Icaroscope looks like a short, stubby telescope.

"The operation resembles the classical polariscope with the important difference that the entire image of a scene is formed upon a stationary screen, and the phosphor is chosen for short afterglow with saturation," said Dr. O'Brien.

The Icaroscope was developed in closest secrecy at the University of Rochester's Institute of Optics under a contract with the OSRD as an aid in defense against aircraft attacking from the general direction of the sun. It was also used extensively in observing and photographing the Bikini atom bomb tests.

*A very readable article on Dr. O'Brien's war-time instrumentation achievements appeared in the Sept. 14 *Saturday Evening Post*.—Ed.

"No-soap" Idea Cures Trouble in Cure-timing Instruments

AKRON, O.—It was strictly a "no soap" idea, the suggestion submitted by Adam Klippel, B. F. Goodrich tube room mechanic, but it won him an award of $500. Klippel's suggestion was designed to prevent soapstone—the powdery form of soap with which inner tubes are coated to keep them from sticking to casings—from accumulating in valves and automatic timing instruments on the presses on which the tubes are vulcanized.

Soapstone, drifting into the timing mechanism through a push-button hole, would occasionally "stop the clock" on a press, causing the press to open prematurely and ruin a tube. Klippel suggested that one of the rubber airplane dust-seal devices manufactured by the company be shortened and inserted to surround the space between the push-button and the automatic timer. The company's entire battery of tube presses has now been equipped with the "boots" and the trouble has been eliminated.

Scientific Glass Blowing and Laboratory Techniques

By WILLIAM E. BARR and VICTOR J. ANHORN, Gulf Research & Development Company

X. VACUUM GAGES *(Continued)*

BOURDON GAGES *(Continued)*

The gage is made as follows:

1. The Bourdon tube is the most important part of the gage. A point is pulled on one end of a 10″ section of 10 mm. tubing. A blow-tube is connected to the opposite end and the glass at the end of the tube is fused and closed. A 1″ section of the tube, just below the closed end, is then fused sufficiently so that a thin-walled bulb can be blown. As the bulb is blown, it is stretched slightly to an oblong shape. It must be remembered that the sensitivity of the gage is dependent on the thickness of the bulb wall. However, if the bulb is too thin it will be too fragile. The bulb is then held perpendicular in a large brushy flame until one side of the bulb is collapsed. The radius of curvature of this side should be ¼″ to ⅛″ less than the other side which is not fused. The sensivity of the gage can be tested by blowing into the blow tube. The point at the tip of the curved tube should move about 3 to 4 mm. from the zero point. The original point is then cut from the tip of the prepared tube and a thin glass rod 6″ long and 1 mm. in diameter is sealed to the tube. The 10-mm. glass tube is then cut 1″ below the Bourbon tube and flared slightly for a ring seal.

2. The Bourdon tube is sealed into a 35-mm. tube after a fine glass point is drawn on the 1-mm. rod. A second glass rod with a fine point is sealed into the jacket. This thin point must be exactly in line and about 1 mm. from the thin point of the gage. An outlet tube is then sealed to the jacket. If the zero point and gage deflection is read with a low-power microscope fitted with an eyepiece scale, the second pointer is not necessary. The outside jacket should then be free of striations.

The gage must be used in a vertical position and the system is connected to the opening in the jacket. One leg of a mercury U-tube manometer is connected to the tube which is ring-sealed to the Bourdon tube. A pressure or vacuum on the outside of the gage will give a movement of the gage pointer. The pointer can be brought to the zero point by balancing this pressure with a pressure on the inside of the tube. This can be done by increasing or decreasing the pressure in the leg of the U-tube manometer by raising or lowering the confined manometer liquid. The pressure can then be read on the manometer.

A Bourdon gage designed by S. G. Foord[5] is a modification of the single pointer gage. The movement of the glass tube is limited by a glass ring, *a*, Fig. 130B, which is attached to the glass tube with a glass rod. When pressure is applied, the movement of the pointer *b* deflects a thin fiber, 0.1 mm. in diameter, to which a small mirror is fastened. Tubes which are fabricated to withstand pressure changes of 1 atmosphere are used. The scale, one meter distant from the gage, can be used to measure the deflection of the gage, which is linear. A ground joint is used to aid in adjusting the lever system. The gage is also surrounded with a water jacket.

A Bourdon gage arrangement with platinum contacts mounted on the pointer and through the gage envelope is illustrated in Fig. 130C.

A second type of Bourdon gage was developed by S. G. Yorke[6]. The essential part of the gage is a thin-walled glass tube spiral. The mandrel arrangement for winding the spiral is shown in Fig. 131A. The gages shown in Figs. 131B and 131C are made as follows:

1. A 6-mm. tube 10″ in length is heated in a ribbon flame and drawn to a diameter of about 1.25 mm. A 12″ length of this tubing is then wound on a 5/16″ diameter mandrel (carbon) which is slightly tapered. A small hole in the end of the mandrel is conveniently used for holding one end of the glass tube while the spiral is wound. This mandrel is mounted in a holder. A metal shield directly below the mandrel should be used to give even heat distribution. The flame is directed against this shield. The thin-walled tube collapses quite easily if it is heated directly with a burner flame. The glass tube is inserted into the hole and the seven or eight turns are carefully wound on the carbon mandrel. The end of the spiral is then cut where it is connected to the mandrel and the spiral is removed.

2. The glass spiral is mounted in two ways. In Fig. 131B a pointer is sealed to the end of the spiral and bent at an angle of 90° to the spiral. The assembly is then ring-sealed into a jacket. A small pointed glass rod is sealed to the opposite end of the jacket and adjusted in line with the spiral pointer. An outlet is then sealed to the jacket.

3. A second way of mounting the glass spiral, which is more accurate, is made as shown in Fig. 131C. The spiral

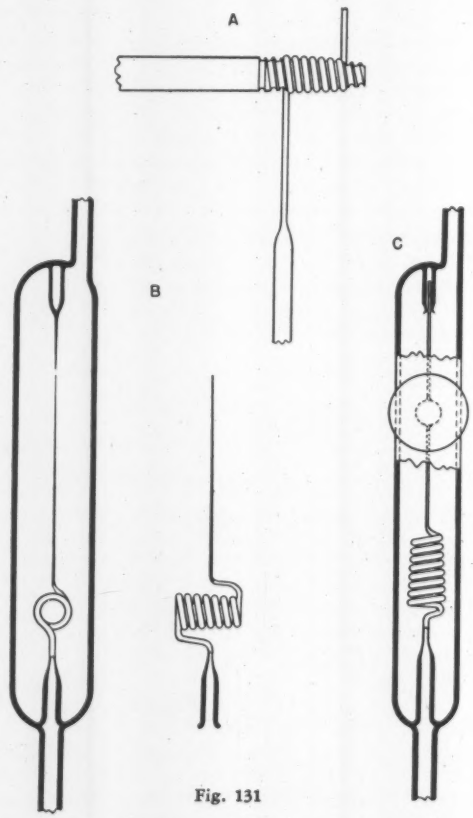


Fig. 131

is in a vertical position and the thin glass fiber pointer is supported at the top by a capillary tube. A small mirror is fastened to the fiber with wax. An optical window is sealed to the jacket in line with the mirror. An increase of pressure inside the spiral gives a movement in the spiral which in turn moves the pointer from the zero point. The gage is balanced by increasing the pressure on the outside of the coil. The gage illustrated in Fig. 131C gives a deflection of 4 to 5 cm. at a distance of one meter from the gage for a pressure change of 10 mm. of mercury.

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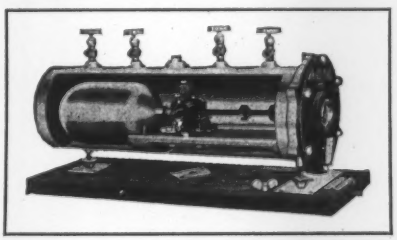

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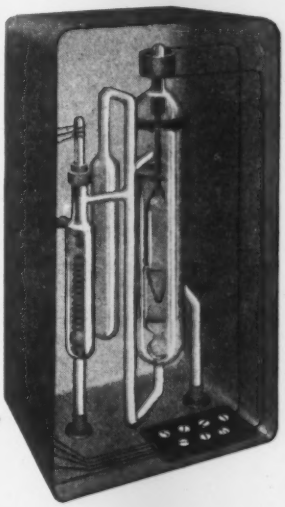

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Pirani Gage

The Pirani gage[7, 8, 9, 10] is used quite extensively. It is simple to operate, small and can also be wired to electric controllers or recorders which in many cases is a definite advantage. This gage has the disadvantage that it is not an absolute gage as it must be calibrated with a McLeod gage for each particular gas.

The Pirani gage works on the principle of a change of resistance of a heated filament with a change in thermal conductance caused by the gas molecules in the gage. The filament is made of a material with a high temperature coefficient of conductance. Measurements are made on a bridge circuit. The pressure is determined by keeping the voltage constant and determining the magnitude of the current flowing through the filament or keeping the current constant and measuring the change in resistance of the filament. In practical operations a second gage under high vacuum is located in a comparative position of the bridge to act as a compensator. The bridge is held at constant voltage. The gage is evacuated to a high vacuum and the remaining two variable resistances are set so that zero deflection is obtained. The gage is then connected to the described system and, as pressure in the system increases, the bridge is unbalanced and current will flow through the galvanometer or microvoltmeter. The scale of such instruments can be calibrated in microns, giving the pressure reading directly. The Pirani gage is sensitive to 10^{-5} mm. of mercury but by special methods may be extended to 10^{-6} or lower.

The Pirani gage can be purchased from numerous manufacturers specializing in vacuum equipment. A gage compensated with a second gage under high vacuum can be obtained from Distillation Products, Inc., Rochester, New York. The Type PG-1A gage has a bridge unit and the vacuum is read on an indicating instrument which has two scales, 0 to 20 microns and 0 to 75 mm. of mercury.

Ordinary light bulbs of the show-case type, Fig. 132, can be used as a Pirani gage. Two bulbs are chosen which have nearly identical resistances. One bulb is used as a compensator in the bridge circuit. The other must be opened so that it can be sealed to the vacuum system. Since the bulbs usually are made of lime glass, a special technique must be employed for opening the bulb. A graded seal from lime glass to Pyrex glass (774) is made from 10-mm. tubing. The end of the bulb is opened by using a hot, pointed tungsten rod 0.04″ in diameter. The end of the bulb is warmed slowly. The tungsten rod is then heated to a white heat and worked through the glass at the end of the bulb by spinning the hot rod with one's fingers. A small point is immediately pulled on the bulb and the glass is opened for the graded seal previously prepared, Fig. 132. The bulb can then be sealed to the vacuum system through the graded seal. This bulb and the compensator bulb form the resistances for the two arms of the bridge while the other two resistances are of the variable type. A circuit for the gage is given in Fig. 133. The calibration curve of a typical gage is given in Fig. 134. The sensitivity of the galvanometer should be 10^{-8} amperes per scale division.

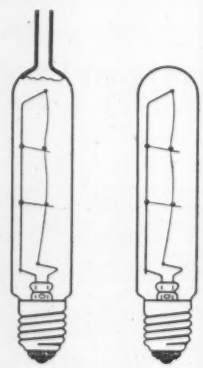
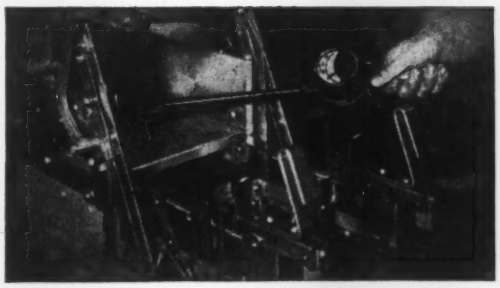


Fig. 132

A small Pirani gage suitable for pressures up to 15 mm. of mercury was developed by E. S. Rittner[11]. The body of the gage is made of 2 mm. Pyrex (774) capillary tubing.



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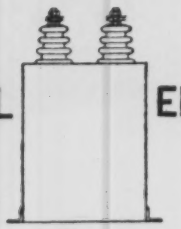
ELECTRICAL  ELECTRONIC

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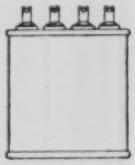

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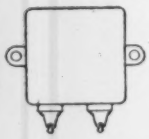

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A 7-mm. tube of the same type of glass is sealed to the capillary for the outlet. The filament is 1-mil tungsten wire 3.5" long and is supported at each end by spot-welding to nickel foil which in turn is spot-welded to 0.04" tungsten rods. The 0.04" tungsten rods are covered with a sleeve of GT-70 glass and beaded with Nonex (772). A narrow band of uranium glass is sealed to the ends of the capillary. The tungsten rods are then sealed to the gage body.

This gage is used in a bridge circuit along with one 13-ohm and two 15-ohm resistors. A galvanometer with a

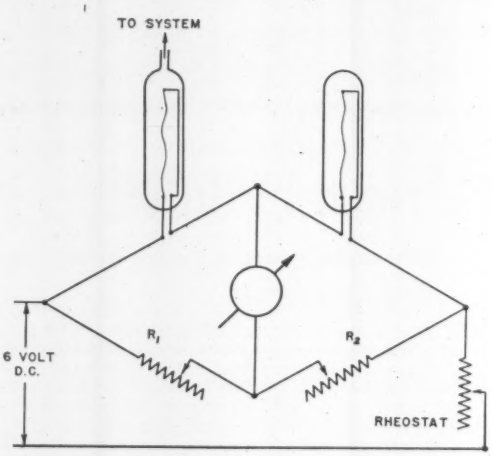


Fig. 133

sensitivity of 2.6 microamperes per scale division and 13 ohms internal resistance is used. A precision of ± 2.5% is obtained in the pressure range of 10 microns to 15 mm. of mercury.

Thermocouple Gages

The thermocouple gage can be used in the pressure range of 0.1 to 10^{-4} mm. of mercury. The gage operates on a principle similar to that of the Pirani gage. The temperature of the hot filament is read by an auxiliary thermocouple which is welded to the filament. The gage requires a simple electric circuit with a constant-current source for the filament.

The thermocouple gage designed by C. C. Dunlap and J. A. Trump[12] is shown in Fig. 135. The thermocouple is made of 3-mil Nichrome and 4-mil Advance wire. The entire length of this thermocouple is 2¾". The filament

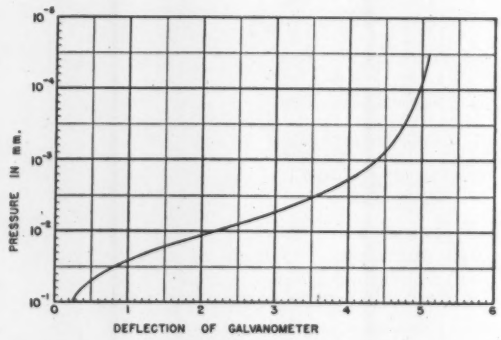
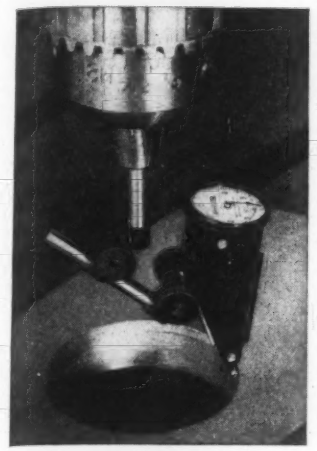


Fig. 134

has the same length and is 4-mil platinum wire. The two thermocouple wires are first spot-welded together with low current and a short welding time. The couple is then spot-welded to the filament. The multiple press is made by first sealing a narrow band of uranium glass (3320) to Nonex (772). Pyrex glass (774) is then sealed to the uranium band and the former is cut and flared for the flare seal. The Nonex (772) section is then cut in the flame and a suitable press is made. Four press welds (nickel rod-tungsten rod-braided copper) are beaded at the tungsten section by the procedure previously given for press seals.



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The bead glass is GT-70. The four beaded wires are then sealed in the prepared press. The nickel wires are then bent so that the four wires, two of the filament and two of the thermocouple, have an umbrella shape after they are spot-welded to the nickel support.

A standard 200 microammeter with an internal resistance of 60 ohms is used to measure the thermocouple current. A

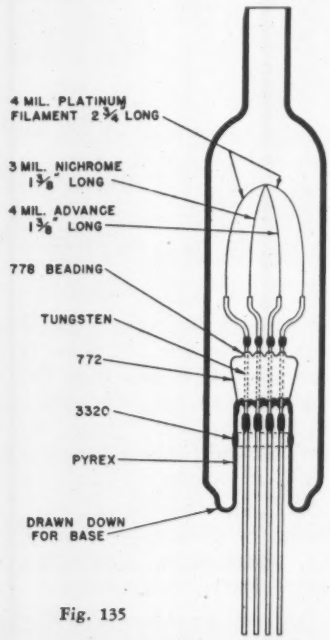

Fig. 135

filament current of 150 milliamperes will give a thermocouple current of 150 milliamperes. The filament power source is 110 volts d. c. with a variable resistance to give currents from 100 to 200 milliamperes.

A typical calibration of this gage is given in Fig. 136. It will be noted that the sensitivity of the gage is best between the pressure range 0.1 to 0.008 mm. of mercury. It has been found necessary to degas the filament when it

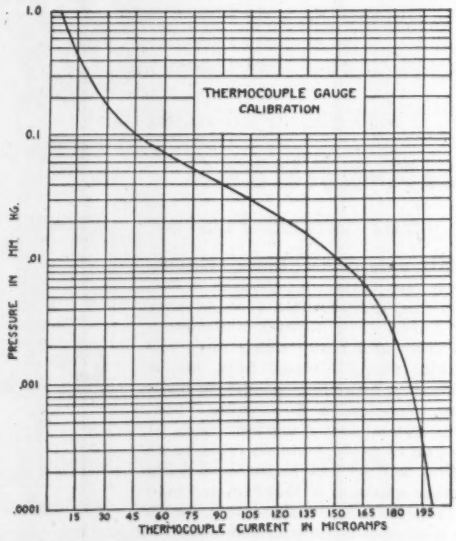

Fig. 136

is exposed to atmospheric pressure by flashing the gage with four times the normal filament current.

A thermocouple gage is supplied by Universal X-Ray Products, Inc., Chicago, Illinois. This gage will indicate pressures down to 0.002 mm. of mercury and is useful for indicating or controlling pressures between backing and diffusion pumps.

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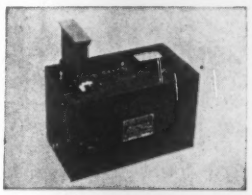

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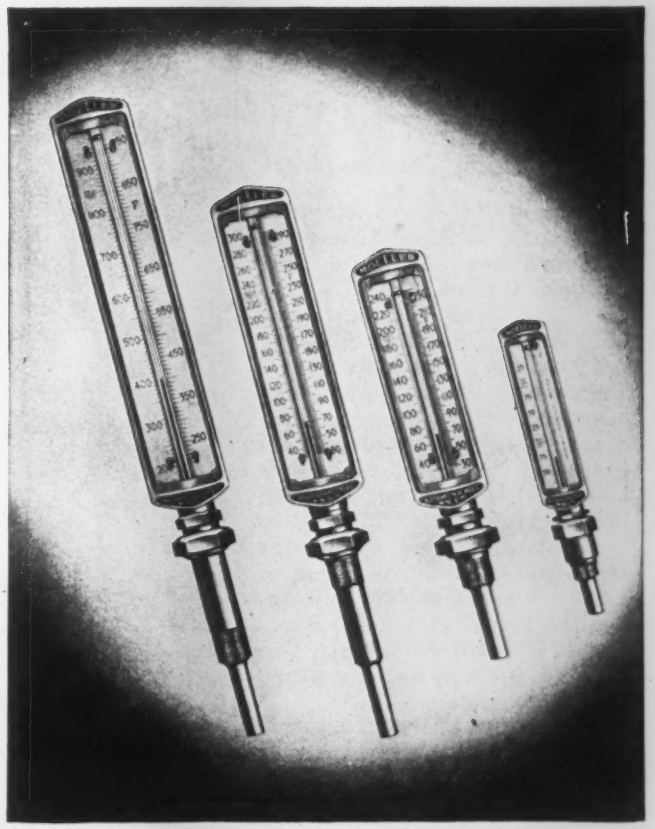

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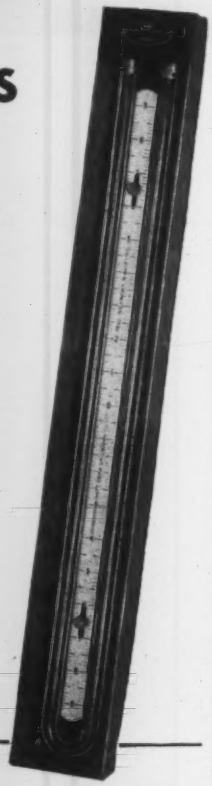

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The Knudsen Gage

The Knudsen absolute pressure gage[13] operates on the principle of measuring the impact of molecules to which a certain amount of kinetic energy has been imparted by a heated filament. The gas molecules come in contact with the filament and, with the added energy gained by contacting the hot surface, impinge on a delicately suspended vane. The deflection of the vane gives a measure of the number of molecules—which is directly proportional to the pressure in the gage. The Knudsen gage is sensitive to 10^{-8} mm. of mercury or better.

A gage of this type studied by J. E. Shrader[14] and R. G. Sherwood was mounted in a Pyrex (774) tube 51 mm. in diameter and 9″ long. The heating strip was platinum 0.018 mm. thick, 7.5 mm. wide and 18 cm. long. This heating unit is folded, forming a cross piece at the top, the two sides are spot-welded to 20-mil lead wires which pass through the glass in a glass-to-metal seal. The side strips are held in place by 15-mil tungsten wires mounted in a glass support. The movable rectangular vane is aluminum 0.0076 cm. thick and 0.5 cm. wide. The vane is mounted by passing aluminum wire through slots in the vane and suspended by 0.5 mil tungsten wire 6 cm. long. A mirror is mounted on the bottom of the vane. An electromagnet on the outside of the gage is used for damping the vane.

Knudsen showed that the pressure of the gage was given by the formula:

$$P = \frac{2K}{(T_1/T_2)^{\frac{1}{2}} - 1} \text{ dynes/cm}^2 \qquad (13)$$

where K = a constant of the gage;
T_1 = absolute temperature of the heating strip;
T_2 = absolute temperature of the aluminum vane.

When small differences between T_1 and T_2 are employed, the equation for pressure becomes

$$P = \frac{4\,K\,T_2}{T_1 - T_2} \text{ dynes/cm.}^2 \qquad (14)$$

The temperature $T_1 - T_2$ is more conveniently expressed as

$$T_1 - T_2 = \frac{R_1 - R_2}{R_0\,A} \qquad (15)$$

where R_1, R_2 and R_0 are the resistance of the heating strip at T_1, T_2 and 0° C., and A is the temperature coefficient of the heating strip. Substituting the value of $T_1 - T_2$ in equation 15 we have

$$P = \frac{4\,K\,A\,R_0\,T_2}{R_1 - R_2} \text{ dynes/cm}^2. \qquad (16)$$

The constant of the gage can be obtained from the physical dimensions of the gage or by calibrating it against a McLeod gage.

A Knudsen gage as described above indicates pressures down to 10^{-8} mm. of mercury when a temperature of 150° C. is maintained between the heater and the vane.

Several modifications of the Knudsen gage have been tested. J. W. M. Dumond[15] and W. M. Pickels produced a gage which is satisfactory for routine measurements.

Ionization Gage

The ionization gage[16, 17, 18, 19] is used for measuring vacua in the range of 10^{-3} to 10^{-8} mm. of mercury. This gage is essentially a triode and works on the principle of indicating the pressure as a function of the plate current. Electrons emitted from a hot filament in the tube are accelerated to an electrode, the grid, and the positive ions formed by the collision of these electrons and gas molecules are collected on a third electrode, the plate. The number of ions formed is directly proportional to the number of gas molecules in the tube and thus the plate current is a direct function of the pressure.

An electric circuit[2] which is used with the ionization gage is shown in Fig. 137. A voltage of 125 is applied between the filament and grid and 25 volts is applied between the

Quick relief between each step. Lead pigs and sandbags applied at end of lever, supported by chain hoist through Dillon Dynamometer. Specimen under test mounted inside structure at right.

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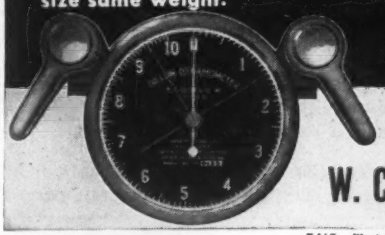

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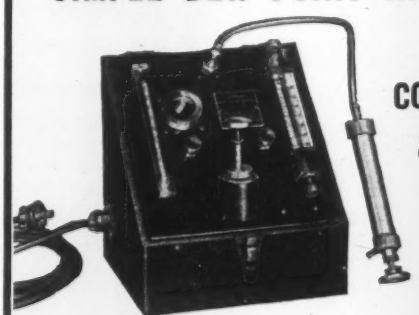

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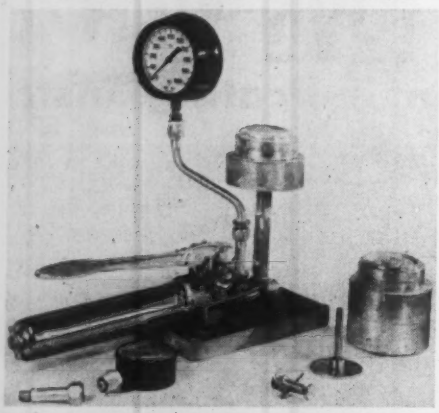

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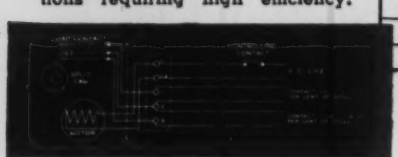

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grid and the plate. A constant filament current is maintained for electron emission.

A modification of the gage developed by R. S. Morse and R. H. Bowie[20] can be obtained from Distillation Products, Inc., Rochester, New York. Data of this gage (VG-1A) are

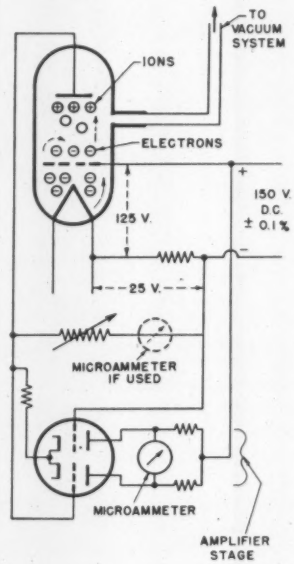

Fig. 137

given in Table 19. The ionization gage is capable of recording the lowest vacuum attainable and electrical leakage and degassing problems are reduced to a minimum.

TABLE 19

PHYSICAL AND OPERATION DATA OF THE VG-1A IONIZATION GAGE

Collector	Thin film platinum
Grid	Spiral tungsten
Filament	Pure tungsten
Envelope	Pyrex Glass (774)
Height	3½"
Diameter	1½" O. D.
Tubulation	12 mm. O. D.
Filament	3.0-7.5 volts 3.5-5.0 amps.
Grid	+150 volts, 5 ma.
Collector	−25 volts, 120 ma./μ

The ionization gage must be calibrated for each gas that is used in the vacuum system. A McLeod gage is used. Extreme precautions must be taken to prevent migration of mercury to the gage and that the pressures are equal through the entire system. A second disadvantage of the ionization gage is that the calibration curves are not linear above 10^{-3} mm. of mercury. The gage can be used only for short intervals above this pressure because of the danger of damaging the hot filament.

Several other ionization gages are commercially available. The National Union Radio Corporation, Newark, New Jersey, supply an ionization gage (Model Nu-R1038) which is capable of measuring vacua in the range 10^{-3} to 10^{-8} mm. of mercury and with a sensitivity of 1 microampere per 10^{-5} mm. of mercury. Another inexpensive gage (VG-2) is supplied by Distillation Products, Inc., Rochester, New York. Several ionization gage control circuits are also supplied by the latter distributor.

The Philips Ionization Gage

The Philips gage[21] is used to read vacua by a principle of recording the ionization current produced by maintaining a high voltage across two electrodes in a tube. A powerful magnet causes the electrons to flow in spiral paths, thus increasing the probability and number of collisions with gas molecules. At low pressures a current of sufficient magnitude is obtained for measurements. Continuous indication is obtained and therefore the gage is quite useful in control systems.

The cathode or filament is preferably made of zirconium or thorium which give a copious supply of electrons when the filament is relatively cold. Since the filament is not hot

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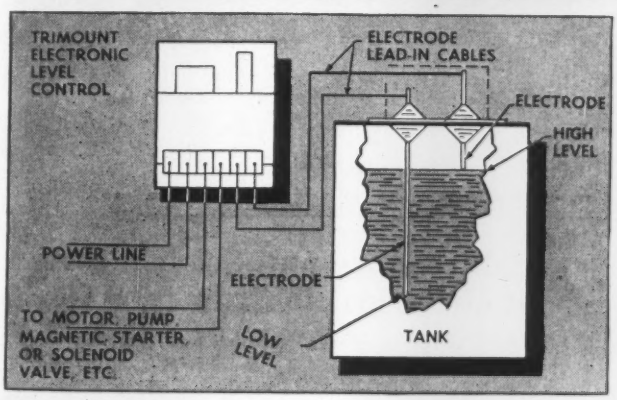

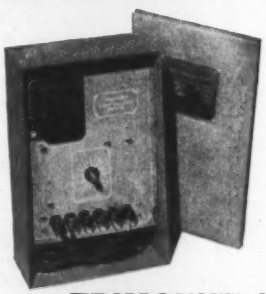

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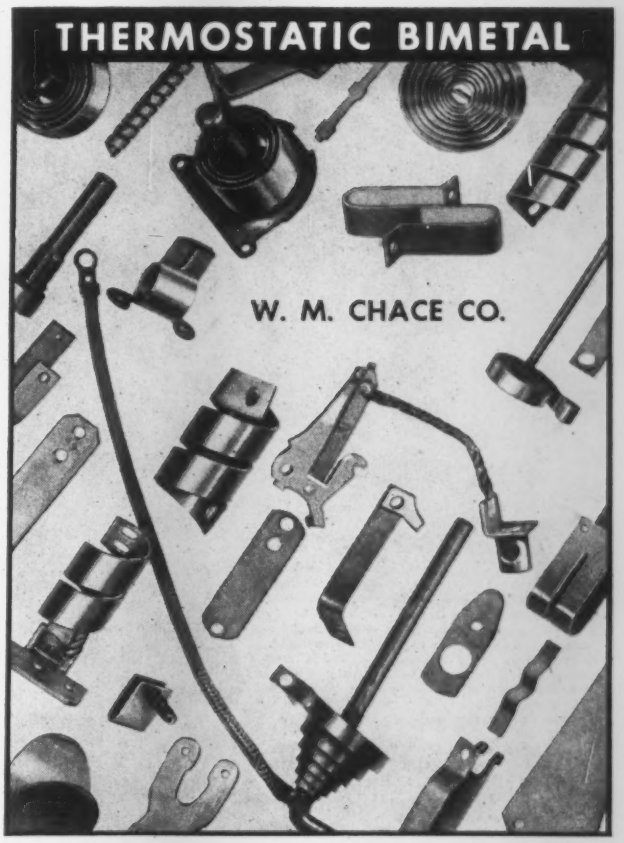

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The electric circuit consists of a transformer which will develop 2000 volts from a 110-volt 60-cycle power source, resistors and capacitors and a microammeter. The gage is calibrated for each gas with a McLeod gage.

The cold-cathode ionization gage, Model U-6000-1-2, supplied by the Universal X-Ray Products, Inc., Chicago, Illinois, will measure pressures in the range of 1.5×10^{-3} to 7×10^{-5} mm. of mercury. The Philips gage, Type PhG-1, supplied by Distillation Products, Inc., Rochester, N. Y., can be used in the pressure range 2.5×10^{-2} to 2×10^{-5} mm. of mercury.

All gages discussed under the second class are electrical in nature and are subject to the disadvantages encountered in electric circuits. On the other hand electrical gages can be remotely located and are easily incorporated in automatic or control systems. It is quite important that a study of each gage be made when one is required in routine or experimental work. Usually it is beneficial to increase the pressure range measurements by using several gages.

To be continued

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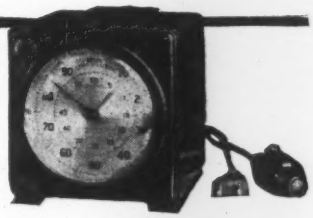

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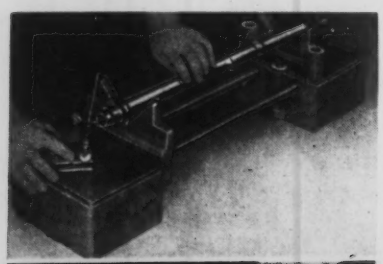

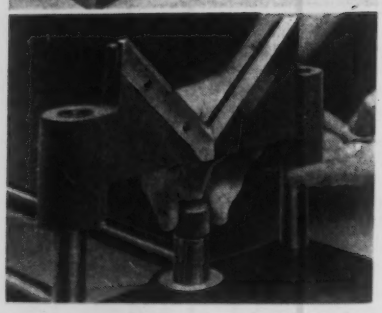

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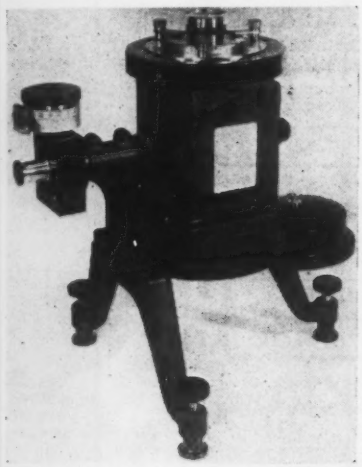

contact with an optical flat is measured to one micron and fractions of this value can be estimated. Instrument is equipped with four interchangeable rings having nominal diameters of 20, 30, 40 and 50 mm. respectively. Rings having diameters as small as 5 mm. and as large as 120 mm. can be supplied on special order.—*The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.*

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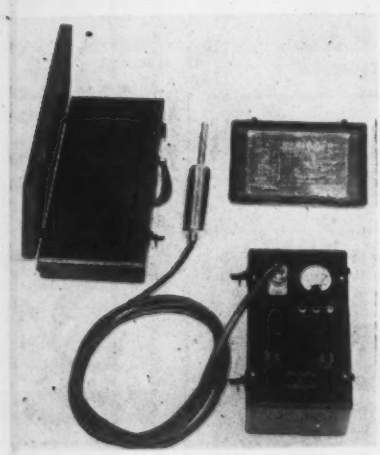

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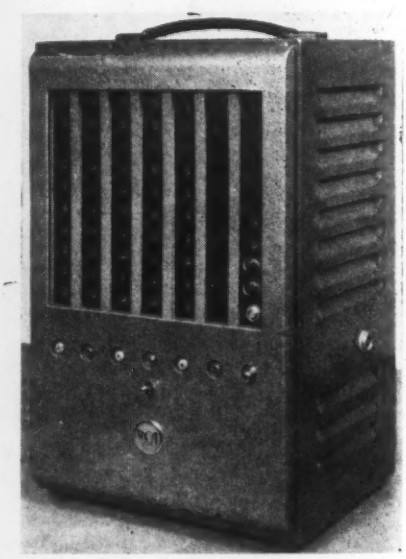

Readings flash on small neon-light figures on front panel of instrument. When used with photocell triggering devices, it permits measuring speeds of objects moving at high velocity (wartime use was at Aberdeen Proving ground), also to produce acceleration curves, etc., in studies of circuit breakers, relays, switches, etc. Time intervals longer than one second can be measured by using an external timer to record the number of times the instrument repeats its operation. Among high-speed counting applications: number of items rapidly passing on a conveyor belt, number of drops of liquid falling from viscosity testing instruments, pill-counting operations in packaging, etc. For automatic predetermined counting, a dial is set and, when preselected figure is reached, instrument triggers an electrical impulse which stops operation, shifts pack-

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Please mention number 1205 when filling out card

Signal Generator

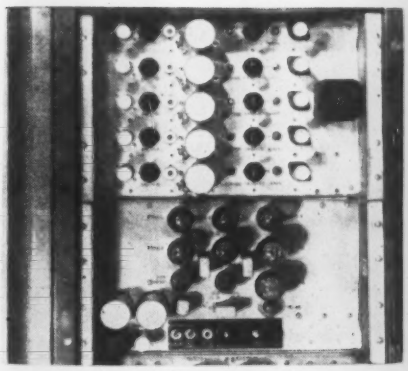
New "Type 202-B" frequency-modulated signal generator covers frequency range from 54 to 216 Mc. and is provided with two frequency deviation ranges, 0-80 kc. 0-240 kc. for FM as well as 30% and 50% calibrations for amplitude modulation. FM distortion at 75 kc. deviation is less than 2%. An internal audio oscillator having eight fixed frequencies between 50 cycles and 15 kc. may be conveniently switched for either FM or AM. By use of an external a-f. oscillator, simultaneous FM and AM may be obtained for checking performance of limiter stages and ratio detectors. A monitoring meter is used to standardize output level of signal generator in order

to make the piston type r-f. attenuator direct reading over the range from 0.1 microvolts to 0.2 volts. Output impedance (with cable attached) is 26.5 ohms. Instrument is self-contained, with power supply, and is designed for use on 115 volts, 60 cycles.— *Boonton Radio Corp., Boonton, N. J.*

Please mention number 1206 when filling out card

Distribution Amplifier for Television Testing

New "Type TA-1A" Distribution Amplifier consists of five separate isolation amplifiers, is especially designed for use with video circuits in television transmitters and synchronizing generators. In a television broadcasting station, it may be used as a



distribution amplifier where video or synchronizing signals from a single source must be fed to several outlets, or as a mixing amplifier where video signals from several sources must be fed to a single line. In laboratories and factories where a video signal from Synchronizing Generator and Monoscope Camera is distributed to a number of receiver test positions, "TA-1A" is used to mix the two signals and distribute the output to the testing positions.—*RCA Engineering Products Dep't, RCA Victor Div., Camden, N. J.*

Please mention number 1207 when filling out card

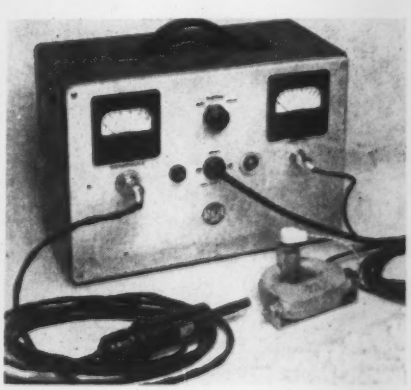
Alarm System for Processing Conditions

New "Air-O-Larm" signalling assembly and system will sound an alarm when predetermined industrial processing flows, temperatures, levels or pressures are reached; is contained in an explosion-proof housing, is adapted to inherently dangerous processing. New assembly is capable of providing either audible or visual warnings.—*Brown Instrument Co., 4482 Wayne Ave., Philadelphia 44, Penna.*

Please mention number 1208 when filling out card

Dual-purpose Vacuum Gage

New "Type EMG Vacuum Gage" provides continuous measurements of pressures as low as 0.1 micron, was designed especially for modern vacuum systems in which rotary pumps are used to back oil diffusion pumps. It will, for example, continuously indicate pressure while the mechanical pump is "rough" pumping and show just when the diffusion pump should be connected. Repetitive accuracy of indicating instrument minimizes error-computing time and maximizes time to be employed in actual operation. "Type EMG" incorporates two types of gage heads—a thermocouple gage and a discharge gage, both having standard pipe fitting for connecting to a vacuum system, each connected electrically to an indicating instrument in the "control unit." All controls are on front panel. Cables and connectors carrying power supply for both gages also extend from

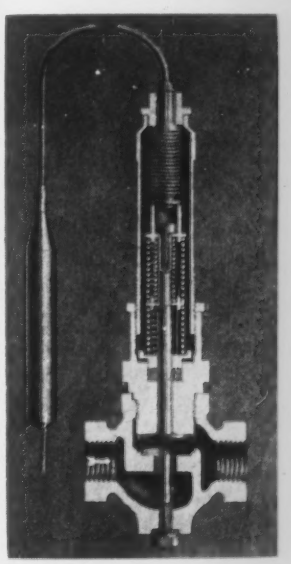


front panel. (1) The thermocouple gage (for higher pressure measurements) is housed in an all-metal enclosure. Circuit flexibility is provided by octal base; threaded mounting facilitates adaptation to various types of enclosures or to a simple fitting. (2) The discharge gage (for low pressure measurements) is a cold-cathode diode type of ionization gage. It contains no filament. Its oval metal shell is surrounded by a permanent magnet which produces a strong magnetic field along minor diameter of shell, establishing it as the cathode. Anode consists of a rectangular loop of wire embracing maximum position of magnetic field. A special feature of new system makes it possible to use the same "meter control unit" with any number and combination of gage heads: these can be permanently installed at various locations and the portable "meter control unit" can be plugged-in at any desired position to obtain a pressure reading. New instrument weighs 18 lbs. complete with gages and cables. It measures 10" high, 13½" wide and 8¾" deep.—*Engineering Products Dep't, RCA Victor Div., Camden, N. J.*

Please mention number 1209 when filling out card

Self-operating Temperature Controllers

New "Class MG-2" self-contained bronze-body temperature regulators for gas control to process heating are supplied with screwed ends in ⅜, ½ and ¾" sizes, operate over standard temperature ranges from 20°F. to 600°F. at inlet pressures up to 25 lbs./in.² maximum. They are designed specifically for gas-heated equipment where product quality depends on temperature control. Various bulb and bulb casing materials are available. Liquid-expansion type thermostatic element has a piston-guided

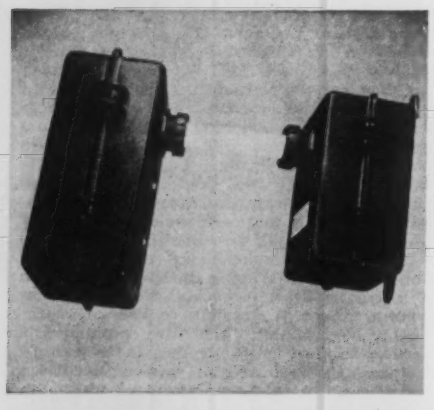


bellows. Free-moving valve stem has yielding springs which prevent overstressing of bellows at over-range temperatures. An unexposed pressure-sealed stuffing box prevents unauthorized tampering with regulator. Costly over-rides in temperature are eliminated by adjustment of pilot flame to lowest point burner permits.—*Leslie Co., 225 Delafield Ave., Lyndhurst, N. J.*

Please mention number 1210 when filling out card

Smoke Indicator

New "Type A20C Photoelectric Smoke Indicator" signals when density of smoke passing through flue or breaching approaches values prescribed by municipal smoke ordinances. It consists of a photoelectric unit and light source, mounted on

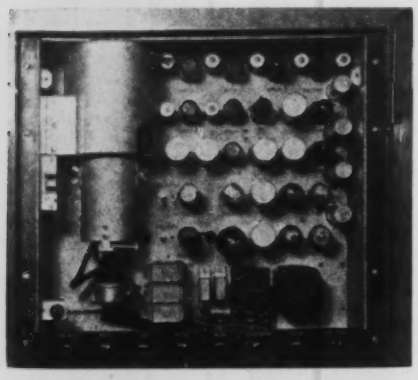


opposite sides of flue. Light source beam is projected across flue onto photoelectric unit. Supplementary equipment includes bell alarms, densometers to give continuous indications and recorders to record time of day at which excessive smoke passes through stack. Equipment operates on 115-volt a.c. Output connections s-p. d-t. for normally-closed and normally-open operation. Weight, 6¼ lbs.—*Photoswitch Inc., 77 Broadway, Cambridge 42, Mass.*

Please mention number 1211 when filling out card

Monoscope Camera for Television Testing

New "Type TK-1A" Monoscope Camera is a complete television camera with a fixed picture image. Produces a test pattern of known quality consisting of a combination



of designs which are particularly important in testing the transmission and reproduction qualities of television receivers, video amplifiers, transmitters, and television picture tubes. It may be used also to transmit radio station call letters.—*RCA Engineering Products Dep't, RCA Victor Div., Camden, N. J.*

Please mention number 1212 when filling out card

Angle-of-attack Indicator

New Angle-of-attack Indicator is a novel flight instrument which its manufacturer predicts will take its place among basic instruments on pilot's panel. It provides warning in advance of approach of dangerous stall-spin condition but, unlike other stall-warning devices which operate only when danger is imminent, it allows a pilot to observe development of a stall in its early stages while there is time to do something. New instrument also indicates the flight condition in which an airplane will use the least fuel per mile flown; is helpful in blind flying, particularly in turbulent air. Instrument's reading is obtained by actually measuring the angle at which the air strikes the wing: a freely moving vane (Fig. 1) on nose of airplane is electrically connected to indicator (Fig. 2) in the cockpit. A red reference marker on dial indicates angle-of-attack which results in stalling of the wing, while a green reference marker shows airplane's most efficient flying angle. Should a pilot fail to see approach of stall, a horn or flashing light will alert him. It was also stated that Angle-of-attack Indicator will help in transition training to faster aircraft with higher wing loading, or to planes which have power controls and which consequently have little "feel." In primary instruction, certain hard-to-teach phases of flight such as the stall,

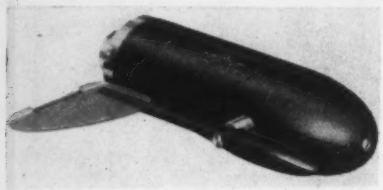


Fig. 1

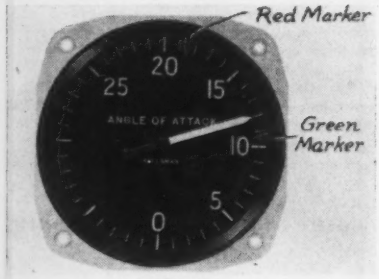


Fig. 2

"mushing," and normal glide, are made easier to understand by the new instrument, it was said.—*Kollsman Instrument Div., Square D Co., 8008 45th Ave., Elmhurst, Long Island City 1, N. Y.*

Please mention number 1213 when filling out card

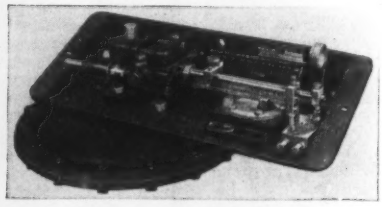
Vacuum-tube Voltmeter

New "Type 1800-A" Vacuum-tube Voltmeter supersedes "Type 726-A" and offers new features and improvements. It is smaller, lighter, and easier to use than older type. It reads d-c. as well as a-c. voltages (ranges 0.1 to 150 volts) and can be used at much higher frequencies: frequency correction curves for both resonance and transit-time effects for frequencies up to 500 Mc. are supplied. Where absolute voltage readings are not required, instrument can be used as a voltage indicator up to 2500 Mc. A single zero setting serves for all ranges. Rated accuracy for both a-c. and d-c. measurements is ±2%. Probe is furnished with variety of fittings, including both coaxial and banana-plug terminals and a 50-ohm disk resistor for coaxial line measurements. Probe cap is removable to give a minimum input capacitance of 3.1 $\mu\mu$f. Input resistance at low frequencies is 25 megohms, decreasing at higher frequencies owing to loss in shunt capacitance. Two input resistances are available for d-c. measusements—10 megohms and open grid. Power supply is 100 to 130 volts (or 200 to 260 volts) 50 to 60 cycles. A voltage-regulated power supply is used. Power input is less than 25 watts. Handle that locks in any one of three positions, permitting instrument to be operated with panel vertical, horizontal, or inclined.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

Please mention number 1214 when filling out card

Pneumatic Transmitter

New adjustable weigh beam for maker's pneumatic pressure and differential pressure transmitters makes possible a 15-to-1 range change without change of parts. Only

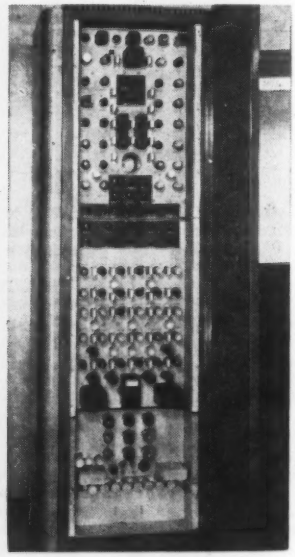


readjustment necessary is rebalancing for zero. New feature consists in replacing standard weighbeam by a double weighbeam having an adjustable pivot between the two halves. With it, a differential transmitter having a minimum range of 0 to 1" of water can be changed to any range up to 0 to 15"; similarly a transmitter with a minimum range of 0 to 8" can be changed to any range up to 0 to 120". *Republic Flow Meters Co., 2250 Diversey Parkway, Chicago 47, Illinois.*

Please mention number 1215 when filling out card

Synchronizing Generator for Television Systems

New "Type TG-1A" Synchronizing Generator is described as the "brain center" of television equipment. It supplies fundamental timing and synchronizing impulses essential for operation of the RMA standard 525-line 30-frame interlaced television scanning system. Equipment is complete

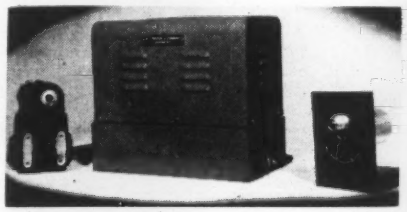


with a built-in regulated power supply, and is assembled in a standard type rack. It supplies both the television cameras and transmitters with the necessary blanking and shading impulses. A built-in oscilloscope makes it possible to monitor the various wave-forms generated.—*Engineering Products Dep't, RCA Victor Div., Radio Corp. of America, Camden, N. J*

Please mention number 1216 when filling out card

Remote-control Servo

New Remote-control Servomechanism, for remote indication or control, consists of three units as pictured. Left to right: (1) Torque unit; (2) Amplifier unit; (3) Control unit. Position of shaft on torque unit is controlled by amplifier to correspond to control unit. System is sensitive to 1% changes in control unit which requires approximately 1 ounce-inch of torque for operation. Torque unit develops a maximum of 50 pound-feet of torque. Amplifier unit consists of three radio type vacuum tubes and associated equipment. A safety feature is provided in the signal light associated with control unit which indicates correct operation of system. System operates from 115-volt 60-cycle power at amplifier. — *G. C. Wilson & Co., 2 North Passaic Ave., Chatham, N. J.*



Please mention number 1217 when filling out card

Roll Thread Comparator

New "Model C Roll Thread Comparator with Pressure Control" is for use by instrument and related industries where thread inspection is necessary on screws of diameters ranging from 0.060" to 0.216" and threads of 80 to 28 per inch National Form 60°. It uses J-S gaging principle with a pressure control feature which relieves operator of responsibility of judging borderline cases. Signal light instantly shows result of full "go" and "not go" functional check on pitch diameter, minor diameter, lead and angle. Screw is placed in work holder where it is held on its major diameter. Operating lever is depressed and screw is presented to gaging rolls. The light is always on except when excessive pressure is applied. Gaging pressure is adjustable.—*Pratt & Whitney, Div., Niles-Bement-Pond Co., West Hartford, Conn.*

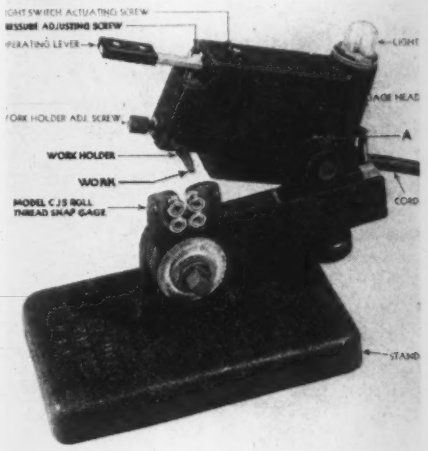


Fig. 1

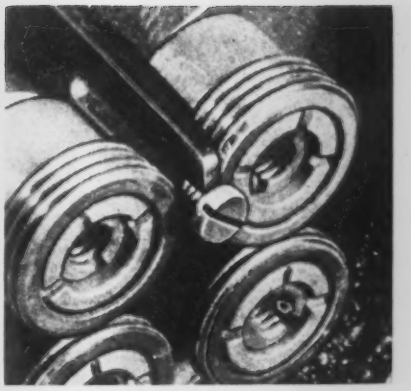
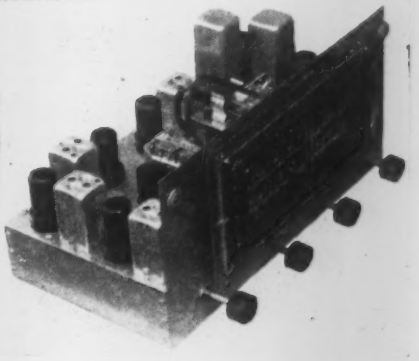


Fig. 2

Please mention number 1219 when filling out card

FM-AM Tuner

New FM-AM Tuner is designed for high-fidelity reception in the new high-frequency FM band as well as the standard broadcast band. Tuning range on FM band extends from 87 to 109 mc. and on broadcast band from 530 to 1650 kc. Armstrong circuit is employed in FM section with two cascade limiters to ensure maximum noise rejection. Dimensions of tuner exclusive of power supply, 7⅜" × 13½" × 9". Power supply is supplied separately. Same unit is available in rack panel for professional installations.



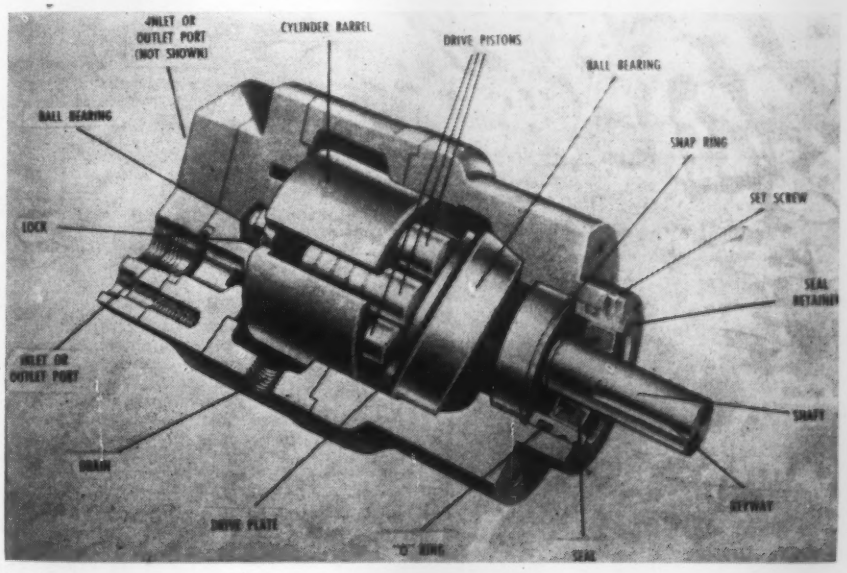
Space has been provided for the power supply in this type of mounting.—*Browning Laboratories, Inc., Winchester, Mass.*

Please mention number 1220 when filling out card

Hydraulic Motor

New "Fluid Motor" of axial piston design gives controlled variable speed, plus instant speed-up control, is said to be applicable particularly where shock-loads present problems for conventional motors. It is available in 3-hp. and 5-hp. capacity; with or without a speed control valve; with or without a choice of geared-head units of various gear ratios; and with a selection of brackets for mounting in any position desired. It is said that exclusive "Floating Drive," wherein constant pressure contact is maintained between driving and driven elements without use of mechanical linkages, eliminates destructive effects of backlash or inertia resulting from sudden starts, stops and reversals. Motor is fully self-starting; operates equally efficient in either direction; can be instantaneously reversed, and is completely self-lubricating. When equipped with speed control valve, motor can be preset to operate at any speed within its capacity. Infinite speed variations are obtained by adjusting a knurled knob. A plunger device interlocked with the speed control valve permits instant acceleration from any preset speed to full speed. When plunger is released, motor returns at once to its preset speed. This plunger device can be controlled by lever, cam or any other arrangement which user may prefer setting up.—*The Denison Engineering Co., Dublin Road, Columbus 16, Ohio.*

Please mention number 1218 when filling out card



Decade Scaling Unit

New "Type YYZ-1" decade scaling unit for random or periodic pulses from one or more sources, indicates number of pulses received up to number of scale in use, and delivers an output pulse for every 10 or 100 input pulses. It is intended primarily for laboratory use in connection with Geiger-Muller counters, mass spectrography, also for accurate counting of extremely rapidly recurring phenomena (resolution time 1 μsec.), such as number of cycles in a high-frequency wave, for timing purposes, or in conjunction with calculating machines. Two or more units can be operated in cascade to provide scaling factors of 1,000, 10,000, or more. Unit is provided with two channels, each operating as decade scalers, each with two parallel inputs and two parallel outputs, and each with a 3½" instrument calibrated from one to nine which indicates number of pulses received up to nine. Tenth pulse causes instruments to reset themselves to zero and next pulse is registered as "one" on instrument. Each instrument

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This convenient instrument combines instant portability with high accuracy and is widely used in laboratory, plant and field. Built for dependable service under hard usage.

- Wide range: 1 ohm to 10 megohms
- Limit of error: 0.1%
- Built-in battery and galvanometer
- Provision for external battery and galvanometer when required
- Available with Murray and Varley loop circuits
- Compact and rugged

... with the Rubicon
PORTABLE KELVIN BRIDGE

For work at very low resistance levels this instrument is the counterpart of the Wheatstone bridge shown above.

- Range: 0.0001 to 10.1 ohms
- Limit of error: 0.25%
- Built-in battery and high sensitivity "Pointerlite" galvanometer
- Provision for external battery and galvanometer when required
- Sturdy and convenient in operation

Wheatstone and Kelvin bridges in a variety of models, together with other resistance measuring instruments, are fully described in Bulletin 100 available on request.

SPOTLIGHT GALVANOMETER

- Sturdy, short period
- Sensitive (up to 0.0006 μA per mm.)
- Multiple-reflection optical system
- For null or deflection measurements

Described in Bulletin 320

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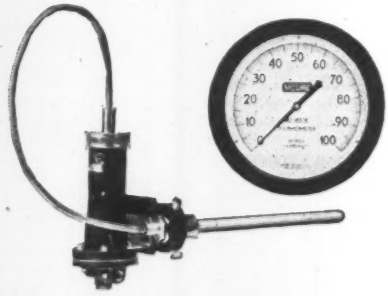
has a reset button, allowing operators to set instrument to zero and start a new series of counts at any time. A separate "count" switch is associated with each channel; the channel not counting regardless of input pulses until the count switch is closed. The two channels are entirely independent and have no interaction. For scale of 100, output of channel One is fed to channel Two, and output is taken from channel Two. In this mode of operation, hundreds and tens are read from left to right on the instruments. Unit requires a minimum peak pulse of 10 volts to operate and maximum counting speed is realized when input pulse is from 10 to 30 volts. Input requires a minimum pulse width of 0.05 μsec. Input impedance is approx. 4700 ohms and the unit delivers a 1 μsec. output pulse of 40 volts peak. All input and output connections are made to the front panel by means of concentric line female receptacles. A switch for placing a 75 ohm impedance across the input is provided for each channel, allowing a variety of possible input connections to other equipment. Each channel, or decade scale, consists of a scale-of-two circuit, the output of which is fed to a scale-of-five circuit. Instrument reads sum of plate currents through the tubes which have been fired by incoming pulses, thus indicating number of pulses received. Unit has a 8¾" high × 19" wide standard relay-rack panel. All tubes except power tubes are shielded. Bottom of chassis is enclosed to provide shielding when rack-mounted. Weight, approx. 50 lbs.—*General Electric Co., Schenectady, N. Y.*

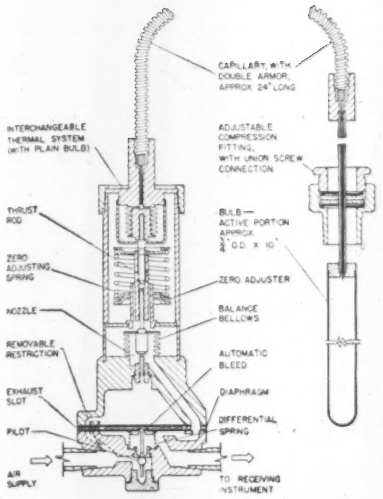
Please mention number 1221 when filling out card

Thermometers with Pneumatic Telemetering

New "Nullmatic Thermometer" converts temperature to air pressure and transmits this pressure to a receiving indicator, recorder, or controller. It utilizes pneumatic



null balance principle whereby pressure in a gas-filled thermal element is balanced by air pressure (see diagram). New instrument provides high-speed pneumatic transmission of the measured temperature over distances of 1000 feet or more and obviates need for long lengths of capillary tubing. Gas-filled thermal element is of new design, consisting of a bulb, 24" double-armored capillary, and a sealing bellows. Thermal elements are interchangeable. Pressure of gas fill does not determine operating range. Standard thermal elements with either of two filling pressures serve for temperatures as low as —150°F. and as high as 800°F. By reason of low filling pressures, instrument has high overload protection: thermal elements for sub-zero applications require no special provision for shipment or storage. Transmission being pneumatic, 30-lb. supply air pressure is highest pressure to which transmitter and receiver are subjected. Operating range of any "Nullmatic Thermometer" may be reset by the use of a suppression adjustment in transmitter, which is also used for setting zero. There are no friction-producing linkages or bearings in the transmitter. Standard instruments are furnished to operate over Fahrenheit spans of 100°, 150°, 200°, 300°, 400°, 500°, 600° and 800° or in Centigrade spans up to 450°C. *Per-*



formance Data: Responds to temperature changes as small as 0.01°F. Detects and transmits temperature changes with a lag coefficient of 2.4 seconds (bare copper bulb in a well-agitated liquid). Speed is not affected by transmission distances up to 75 feet. Addition of each 100 feet of ¼" O.D. line results in a transfer lag of approx. one second.—*Moore Products Co., H & Lycoming Streets, Philadelphia 24, Pa.*

Please mention number 1222 when filling out card

Recorder-controllers With Improved Air Relay

New "PQR" 6" chart-size recorder-controllers are added to maker's larger recorder-controllers (12", 10" and 9" chart sizes). Recording mechanisms have same Bourdon-tube movement as larger models and their guaranteed accuracy is one scale division. Instruments take only "one-third of space necessary for conventional larger units," panel cutout size being 6½" × 8½" and outside flange 7¾" × 10". Interlocking chart plate feature permits one-handed chart removal without tools. In automatic-control mechanism, new feature is "PQR" (proportioning quick response) air relay, a non-bleed type designed to provide "immediate proportionate response of the diaphragm valve regardless of the distance of the diaphragm valve from the control instrument." Its operating principle may be inferred

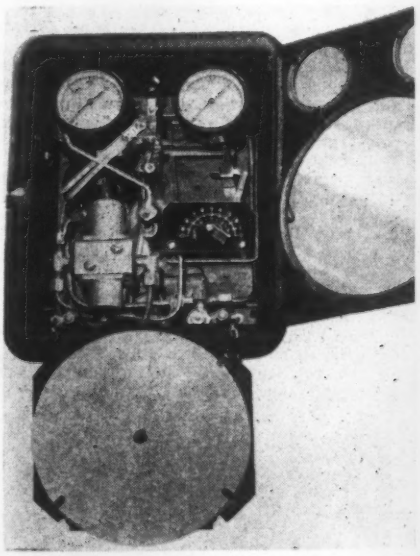


Fig. 1.

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Nor are we satisfied that ordinary production and inspection methods offer you adequate quality protection . . . we *individually test* each Arnold magnet in a loud speaker structure before shipment.

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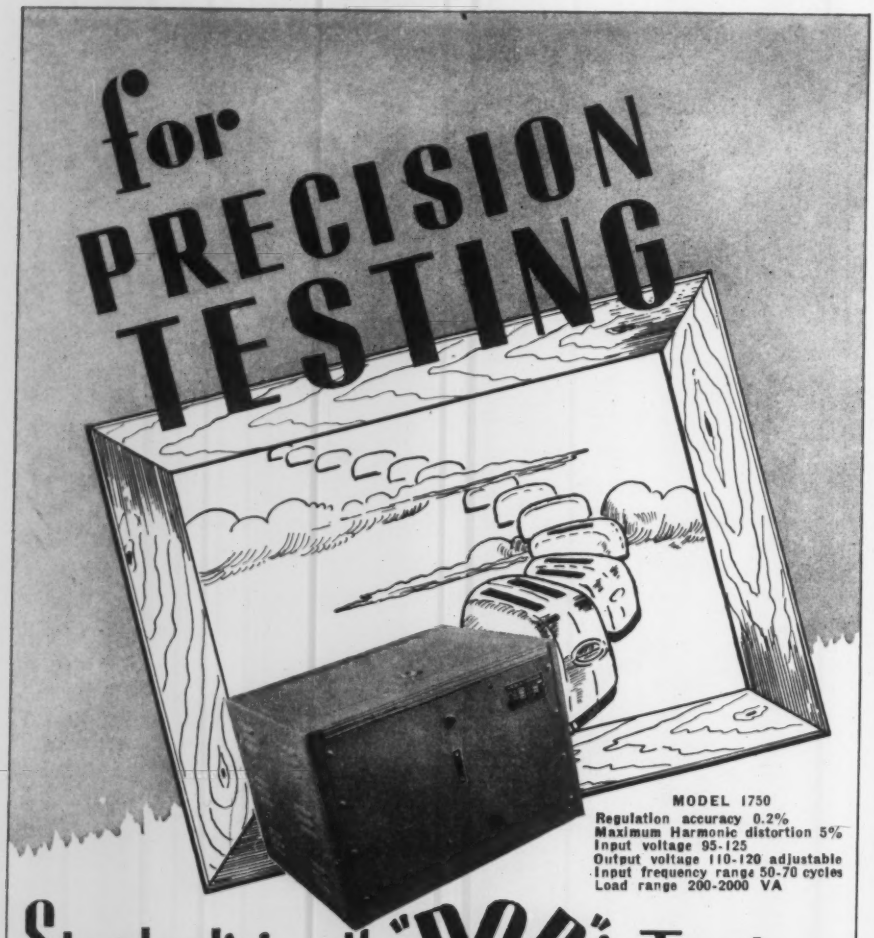

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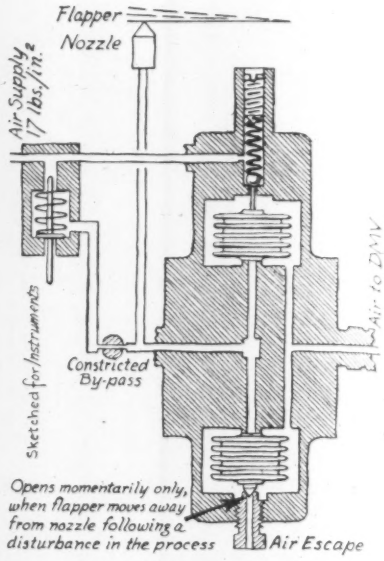


Fig. 2.

from Fig. 2 which is a symbolic and schematic sketch rather than a true drawing.—*Gotham Instrument Co., Inc., 149 Wooster St., New York 12, N. Y.*

Please mention number 1223 when filling out card

Geiger-Mueller Counter

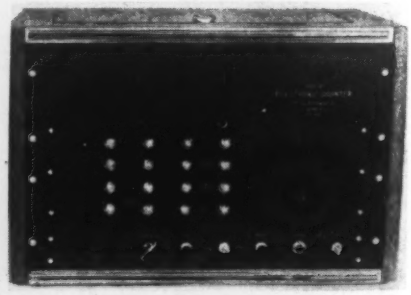
New "Model 337" Geiger-Mueller Counter is said to be built to precision standards for the physical laboratory and industrial research, utilizing a scale of 64 with pro-

vision for switching to a scale of 8 if desired. Power supply is completely a-c. operated and is continuously variable from 0 to 2000 volts. A shock-mounted and insulated impulse register is contained within instrument. Counter has convenient front panel switching of power, reset, start and stop counting, with panel light indication and aural monitoring with volume control adjustment. Cabinet size 20" wide, 13½" deep and 10" high.—*Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio.*

Please mention number 1224 when filling out card

100-kc. Decimal Scaler

New "Model 85 Decimal Scaling Circuit" is designed to respond to pulse rates as high as 100 kc. per second in conjunction with Geiger-Mueller radiation detecting circuits.

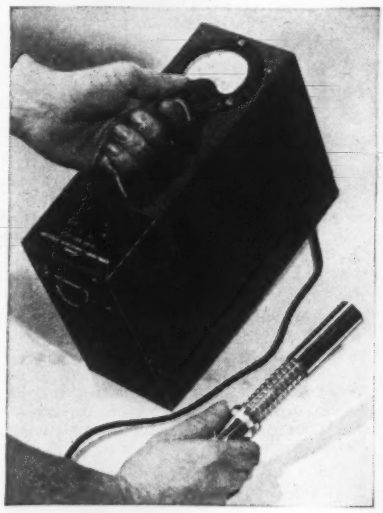


By means of a simple plugging operation it is possible to obtain scaling factors of 10 to 1, 100 to 1, 1000 to 1, or 10,000 to 1. Higher scaling factors are available in other models. Instrument uses four 4-tube decades of standard design, with input shaping circuits and power supply. Power consumption is 150 watts at 115 volts, 60 cycles. Output is designed for operating a Cenco type impulse counter. Special output circuits for specific requirements can be provided. — *Potter Instrument Company, 136-56 Roosevelt Avenue, Flushing, N. Y.*

Please mention number 1225 when filling out card

Radioactivity Probe

New "Model 2610" portable beta-gamma count rate meter, for locating radioactive products which may be health hazards or may exist as stray materials in lockers and

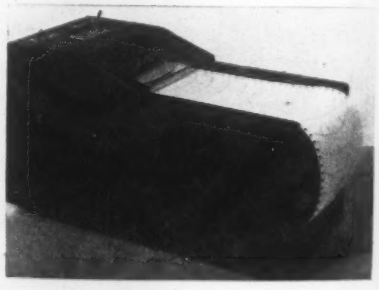


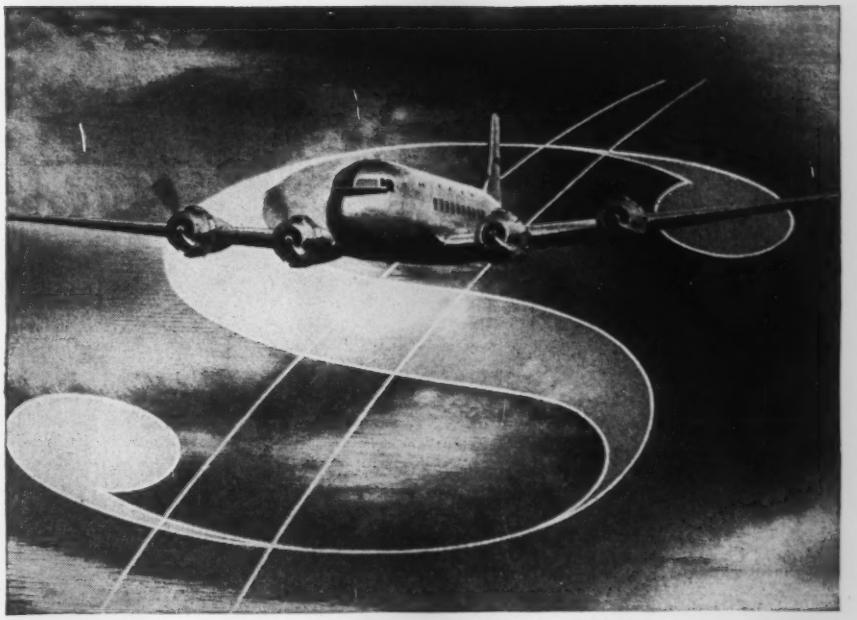
work rooms, or on desks or clothing, may also be used in radioactive ore surveys. It has three ranges—0.2, 2, and 20 milliroentgens per hour full scale—which gives instrument a range below cosmic ray background and above tolerance level. Probe is detachable, has 4-foot cable for holding Geiger-Mueller tube. To distinguish between beta and gamma rays, window of probe has an adjustable shield that can be set to prevent beta particles from affecting Geiger-Mueller tube. A double-receiver headset is furnished for rapid surveying operations. Instrument is battery-operated. Battery life, based upon an average operating period of four hours per day, is estimated to be 500 hours. Entire unit weighs 10 lbs., and is housed in a metal cabinet measuring 8" × 11" × 4". — *Instrument Development Laboratories, 817 E. 55th Street, Chicago 15, Illinois.*

Please mention number 1226 when filling out card

Recorder for "Profilometer"

New "BQ Reading Recorder" is a new model recorder for use with "Profilometer" surface roughness analyzer (see *Instruments*, July 1939, page 173; April 1942, page 142; May 1942, page 158). Chart





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549	1.07	1.42	3.84	6.14	15.35c
1049	1.17	1.98	7.68	12.28	30.70c
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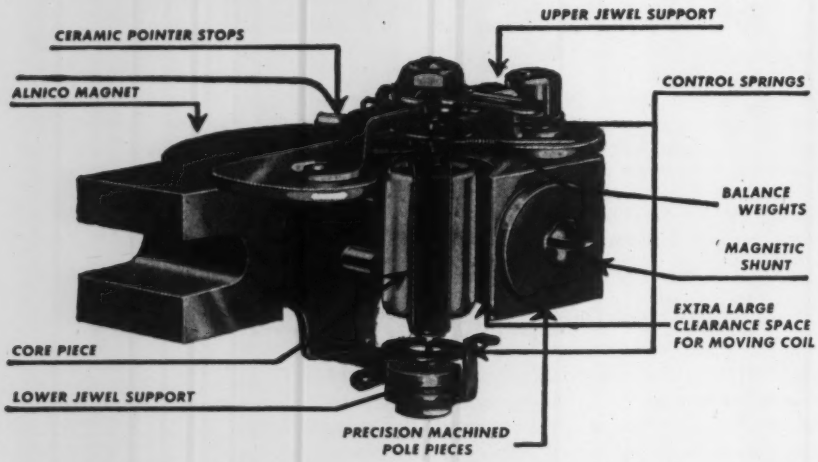

1. MAGNETS OF ALNICO, the most stable magnetic material available, are used in all DC instruments.
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3. JEWEL SUPPORTS are machined and assembled with aid of precision gauging fixtures to maintain perfect alignment.
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5. CERAMIC POINTER STOPS are used to prevent damage to the pointer due to accidental application of sudden overloads.
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7. MAGNETIC SHUNT is standard equipment on each DC instrument, insuring uniform damping characteristics.

All ranges AC and DC are available in 2½", 3½", 4½" sizes, both rectangular and round case styles. Inquiries for complete information and engineering service are solicited.

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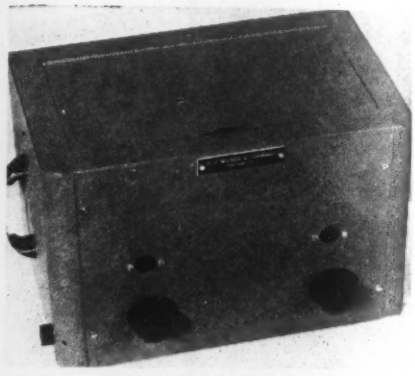
width, 6"; dimensions, 8"×17"×10"; weight, 40 lbs.; power, 115-volt 60-cycle (other voltages and frequencies on special order). —*Physicists Research Corp., 343 S. Main St., Ann Arbor, Mich.*

Please mention number 1227 when filling out card

Strain Gage Amplifier

New amplifier particularly suitable for vibration studies provides amplification of 25,000 between 1 and 30 cycles. Designed

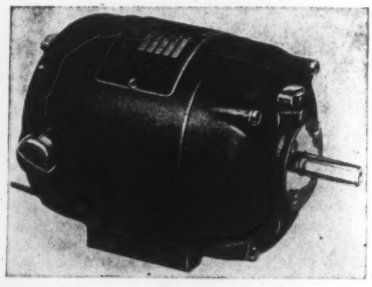


to couple directly to the plates of a cathode-ray oscilloscope, unit includes its own electronically regulated power supply.—*G. A. Wilson & Co., 2 N. Passaic Ave., Chatham, N. J.*

Please mention number 1228 when filling out card

Instrument Motor

New "Type EU-450 Ostermotor" is a high-speed 1/15-hp. series-wound continuous-duty motor with high starting torque and varying

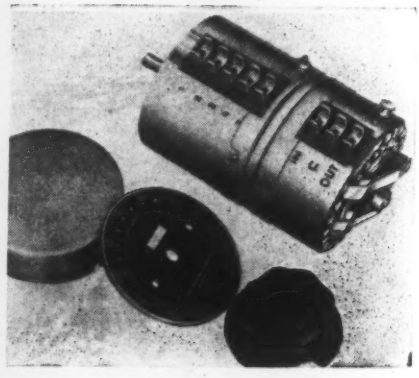


speed characteristics. It operates at 4000 to 8000 r.p.m. full-load speed on both a.c. and d.c. Dimensions: 4½" over-all, 3 21/64" diameter; weight: 3 lbs. 13 ozs.—*John Oster Mfg. Co., Racine, Wis.*

Please mention number 1229 when filling out card

Tone-compensating Attenuator

New "Type LAC-720 Tone Compensating Attenuator" was developed to enable authentic reproduction of the musical spectrum. It is essentially a ladder network, designed so that frequency characteristics

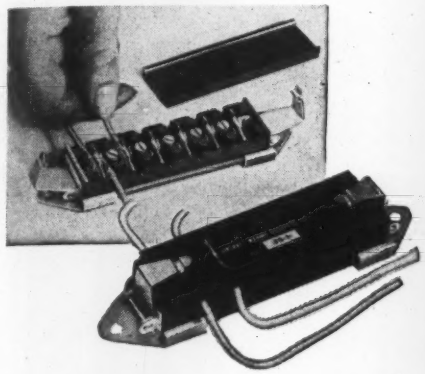


follow hearing response curves of human ear. Thus bass frequencies have a smaller loss than middle or upper registers, without rendering a false or "pumped" response. By proper external connection it is possible to obtain six different Attenuation *vs.* Frequency curves varying from the "human ear type of response" to a flat frequency response. When unit is wired for a flat ladder of 2.5 db per step.—*The Daven Company of 191 Central Ave., Newark, N. J.*

Please mention number 1230 when filling out card

Connector Block

New "AMP Connector Block" provides a quick and positive means of electrical connection for as many as 24 pairs of wires,

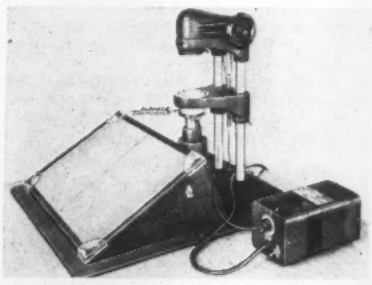


has been designed so that two solderless "AMP Knife-Disconnect Splicing Terminals" may be connected within their own length. Wires are connected, by means of these terminals attached to their ends, to either side of integral metal members within plastic body. These parts are held in place by insulated or metal screws—simple replacement of an insulated screw with a metal screw providing the means of interconnecting any two adjacent members. Connection is made by inserting knife-disconnect terminal vertically into a well in the block and pulling back on the wire; disconnection is made by reversing this procedure. "AMP Block" shown is 1¼" wide and ¾" high, with connector members 9/16" on centers.—*Aircraft-Marine Products Inc., 1502-D North 4th St., Harrisburg, Penna.*

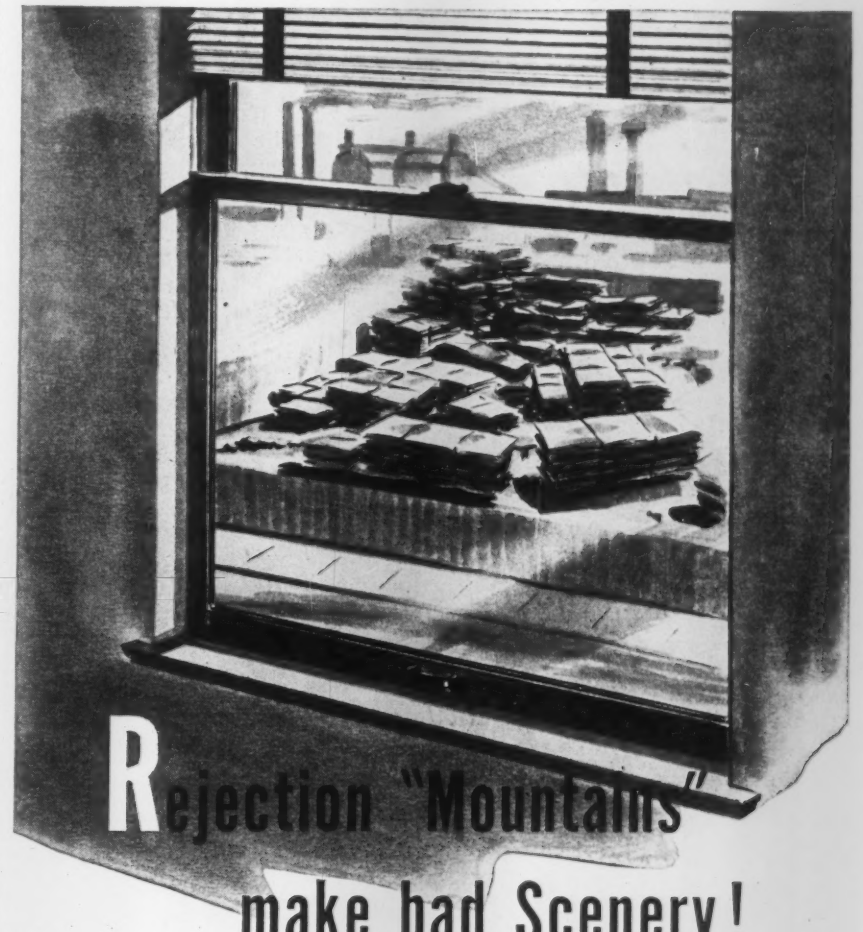
Please mention number 1231 when filling out card

Surface Reflector for Wilder Projector

New type of reflector or surface illuminator for Wilder Projector (*Instruments*, Oct. 1943, page 652) represents a radical departure from previous methods, in that it



uses a ring of eight low-voltage bulbs, mounted in a circular lamp house which surrounds projector lens. High-intensity light is directed vertically against surface of workpiece to provide uniform illumination over full area of lens and screen without shadows. New surface illuminator is instantly removable from lens, though it may stay in position without interfering with regular projection in transmitted light. (Wherever desirable, image can be pro-



Rejection "Mountains" make bad Scenery!

Of course in your particular industry they may only be "mole hills" but whatever their size they represent loss in manpower, time, money and material.

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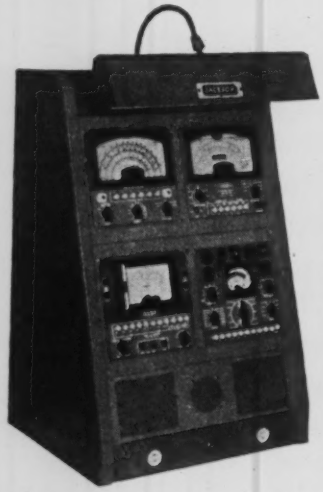

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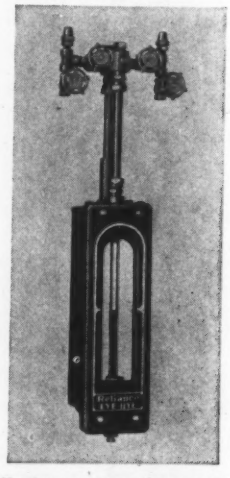
duced jointly in transmitted and reflected light.) To make surface illuminator self-contained and applicable to instruments now in the field, it is operated through a separate (constant-voltage) transformer.—*George Scherr Co., 200 Lafayette St., New York 12, N. Y.*

Please mention number 1232 when filling out card

Liquid Level Indicator

New "Model E-32 Eye-Hye" remote-reading liquid level indicator has an altered construction said to achieve greater compactness and certain structural advantages.

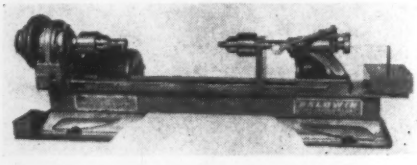


Plastic diffusing screen improves distribution of interior illumination. Case has been made drip-proof and interior more accessible for cleaning and renewing of lamp.—*Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland, Ohio.*

Please mention number 1233 when filling out card

Wire Torsion Testing Machine

New torsion testing machine for wire (developed by Sonntag Scientific Corp. and is sold exclusively by undersigned company)

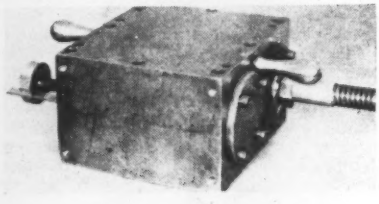


will test bronze and copper trolley wire, telephone and telegraph wire and steel tie wire from 0.090″ to 0.75″ in diameter in accordance with ASTM specifications. Three twisting speeds, 10, 20 and 30 rpm., with reversible rotation, are available with a maximum torque of 1000 inch-pounds. Stresses up to 80,000 lbs./in.² can be obtained on ½″ specimens. Specimen can be preloaded in tension and a reset type counter disengages automatically when specimen fails. — *Baldwin Locomotive Works, Philadelphia 42, Penna.*

Please mention number 1234 when filling out card

Oscillator for Vibration Tests of Structures

New "Sonntag LA-1 Oscillator" is easily attached to a structure or machine to induce vibrations in dynamic testing. It weighs

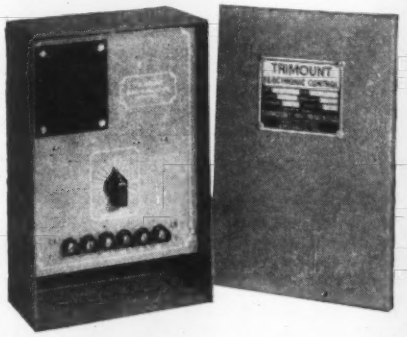


61 lbs. Centrifugal force produced by eccentrically-supported weights, rotated so that all forces add in one direction and cancel each other in all other directions, provides vibration. Force is steplessly adjustable either while running or stationary by turning micrometer type knob. The maximum allowable force of oscillator itself is 1600 lbs. but this is multiplied in resonance with the structure under test. Multiplication factors as high as 200 are said to have been encountered, making oscillator in effect capable of producing loads of 320,000 lbs. Oscillator is provided with two types of drive: either a flexible shaft that will permit motor to be mounted away from oscillator, or a V-belt drive for direct mounting. Also available as a standard accessory is a caster-mounted control cabinet and desk combination that provides space for reading instruments and controls as well as storage of oscillator and accessories.—*The Baldwin Locomotive Works, Philadelphia 42, Pa.*

Please mention number 1235 when filling out card

Automatic Level Controller

New "Electronic Level Control" for controlling high, low, and intermediate levels of liquids and conducting solids in open

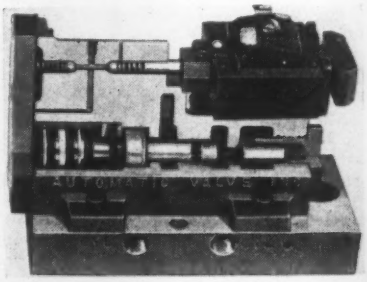


or closed vessels, features "Adjustable Conductance Control." An electrode installed in the container actuates a magnetic relay when it comes in contact with the conducting substances. Control unit commands solenoid- or motor-operated valves, pumps, lights, alarm signals, etc. New conductance control is adjustable to conductivity of a specific substance and is not affected by foam or foreign matter on top of liquid. Units are available with circuits to handle one or more electrodes, and can be furnished in multiple installations for controlling a series of levels or various mixtures.—*Trimount Instrument Co., 37 W. Van Buren St., Chicago 5, Illinois.*

Please mention number 1236 when filling out card

Four-way Solenoid Air Valve

New "Model SV-4" is a 4-way 4-port solenoid-operated air valve with positive high-speed operation, specially designed for



controlling air cylinders for machine operations. It is small and light enough for mounting close to air cylinders, eliminating excessive piping. New valves are of pressure-sealed poppet shuttle type, stemless, with ⅛" solenoid plunger travel and are made in ¼", ⅜", ½" and ¾" sizes. Oper-

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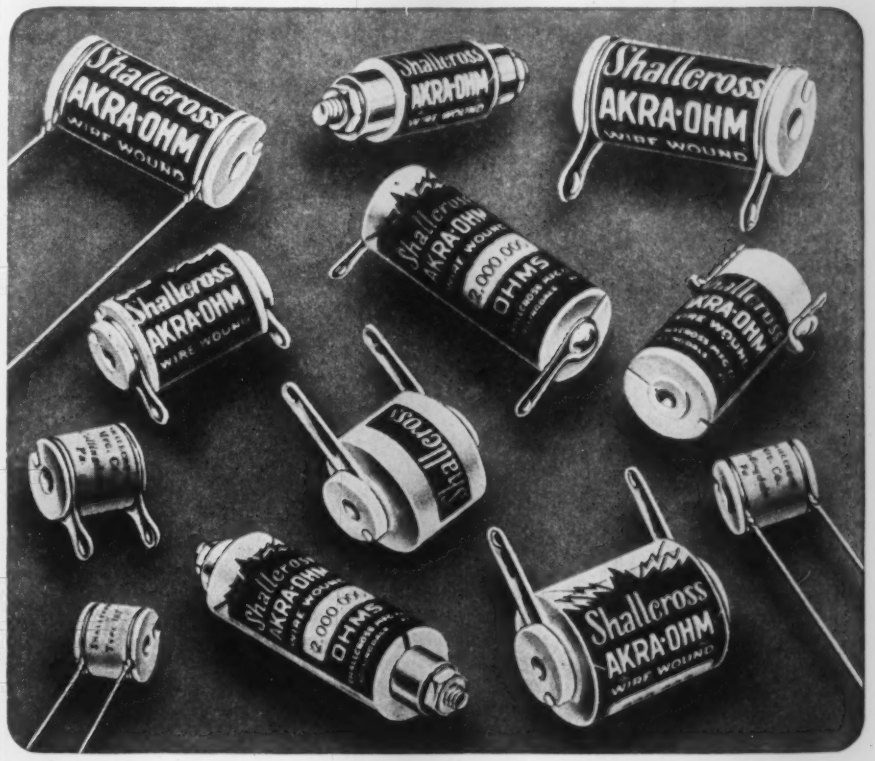

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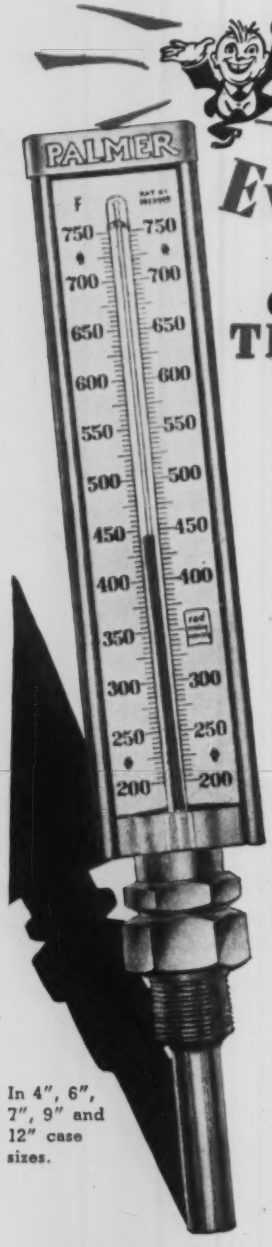

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about this GREAT NEW THERMOMETER

WE don't expect **your** temperature to rise, but frankly, everyone's excited about the new Palmer Extruded Brass Case Thermometer. Never, since the introduction of the now-famous "Red-Reading-Mercury" by Palmer, have such exclusive and important advantages been offered to industry.

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In 4", 6", 7", 9" and 12" case sizes.

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ating power values are low: 1.42 amp. in-rush at 110 volts, 60 cycles, 0.22 amp. sealed. "SV-4" is also made in 5 port type for differential air pressures, 0-150 lbs. All parts, both of 4- and 5-port types, are interchangeable. They can be mounted in any position—no special tools required—and can be serviced without disturbing piping.—*Automatic Valve, Inc. of 37415 Grand River Avenue, Farmington, Mich.*

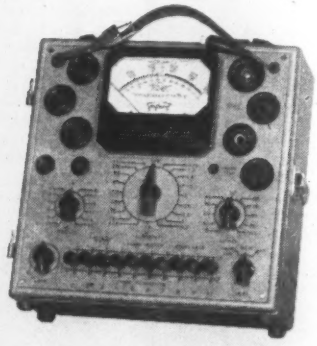
Please mention number 1237 when filling out card

Mobile Test Set for Aircraft Instruments

New Portable Aircraft Instrument Field Test Set is a wartime innovation built to meet the complex needs of an expanded airforce, said to have increased field testing operations 500%. New set conducts thirty simultaneous instrument test operations, affords automatic protection to both master instruments and instruments under test by a series of relief valves and calibrated orifices. Unit is an outgrowth of standard AAF test set, with radical additions and improvements: it functionally divides testing operations into smaller groups, permitting nine separate tests to be run from one carrier. For specialized testing, superfluous units can be replaced with more of one type. Self-contained power unit of three small motors permits operation on any lighting circuit. Provision for quick-detachable couplings speeds up aircraft instrument testing. Unit is of low design, permitting ready access to planes from under-wing approaches.—*Red Star Products Co., 2915 Detroit Ave., Cleveland 13, Ohio.*

Electron-tube Tester

New "Model 2425 Transconductance Reading Tube Tester" is said to have twenty exclusive features. Microhmo (dynamic mutual conductance) readings are made



possible through a simple measurement directly proportional to G_m and a properly-calibrated measuring instrument. No possibility of grid overloading. "Short" and "open" tests of every tube element. Gas test rounds out full check of all tubes. New "Easy-Test Roll Chart" also available. Metal case, 10" × 10" × 5¾", with attached handle and removable cover, is for counter or portable use.—*The Triplett Electrical Instrument Co., Bluffton, Ohio.*

Please mention number 1238 when filling out card

Multi-range Multi-head Tachometer

New "Type 40E" switchboard tachometer has permanently-mounted tachometer heads at five different machines. Heads are wired by ordinary BX cable or conduit to central

indicating unit which has a rotary selector switch. Machines may be in remote buildings and indicating unit in the superintendent's office. Another rotary selector switch is for selecting any of three speed ranges, between 1 rpm. full-scale and 50,000 rpm. full-scale. Heads are cam-actuated reversing switches whereby a capacitor is charged and discharged (see *Instruments*, Dec. 1945, page 922). Accuracy is 1%.—*Metron Instrument Co., 432 Lincoln Ave., Denver 9, Colo.*

Please mention number 1239 when filling out card

Midget Aircraft Tachometer

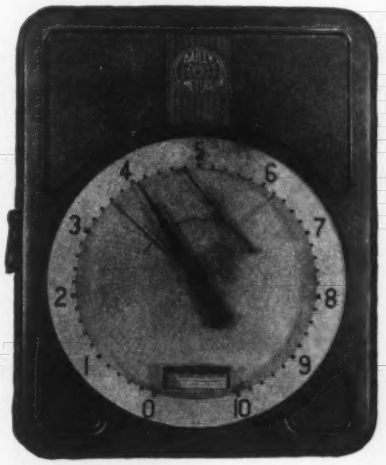
New electric aircraft tachometer indicators, believed by GE engineers to be "world's smallest," have a scaleplate nearly one-third

smaller in diameter than previous models with little sacrifice in readability. Weight is correspondingly less. Indicators operate on magnetic-drag principle: magnets rotate at a speed proportional to engine speed and cause a drag disk to drive a pointer upscale. Pointer comes to rest when torque exerted by drag disk equals torque of a calibrated spring. — *General Electric Co., Schenectady, N. Y.*

Please mention number 1240 when filling out card

Recording Tachometer

New recording, indicating and controlling tachometer, consists of a heavy-duty magneto generator used in conjunction with

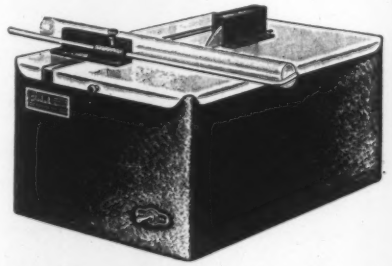


maker's standard "Electronic Recorder." Generator may be connected to a roller or shaft either directly or by means of a V-belt or sprocket-and-chain drive. Recorder is connected electrically, can be placed in any convenient location, is calibrated to record in terms of rpm. of the roller or fpm. of material or both. A step-up drive is used if maximum speed to be measured is less than 100 rpm. Generators are insured a long life and low maintenance costs by operating under a low load. This is accomplished by placing a high resistance across the generator connections and tapping off a portion of the resistance. By doing this, only millivolts are applied to the recorder and current flow is reduced to approx. 0.002 amp.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.*

Please mention number 1241 when filling out card

Glass Tubing Cutter

New Glass Tubing Cutter is equipped with a 5″ steel cutting wheel; a "crystalon" wheel 1/16″ thick is also provided. Wheel speed is 3400 r.p.m. through a V-belt drive;

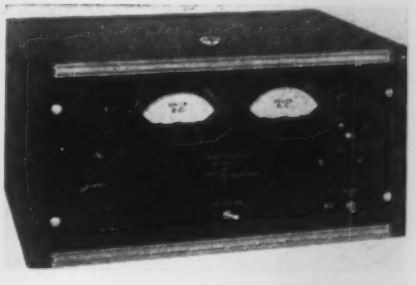


oil-lite bronze bearings insure longer life. Overall dimensions are 9″ high by 10½″ wide by 16″ long. Off-on toggle switch mounted on front of case controls operation on 110-volt 60-cycle a.c. Pyrex glass tubing up to approx. ½″ O.D. can be scored or grooved; soft glass tubing up to approx. ¾″ O.D. can be handled easily; tubing is then snapped apart. With large tubing a groove is scored around tube at point where cutting is desired; when groove encircles tube, tube may be held against wheel in one place, and generated heat causes tube to separate along prepared groove. When silica or porcelain tubing is to be cut, "crystalon" wheel completely severs the piece. "Crystalon" wheel operates efficiently when cutting the larger sizes of Pyrex glass tubing. Top of machine may be easily removed for changing wheels. A rack is provided inside case for storage of extra wheels.—*Eberbach & Son Co., Ann Arbor, Mich.*

Please mention number 1242 when filling out card

Regulated D-c. Power Supply Units

New "Models 310-A and 310-B Power Supplies" have been especially designed for d-c. production and laboratory tests. For convenience in testing under a-c. as well as d-c. operation, a switch is provided in "Model 310-A" to connect desired type of current to an output receptacle on front panel: In its "DC" position, regulated output of power-supply will be available at this receptacle; in its "AC" position a direct connection is made to the a-c. power line which energizes the instrument through a variable auto-transformer. This



Variable Speed Drive Attachment Offers Instant Speed Control for Drill Press Work!

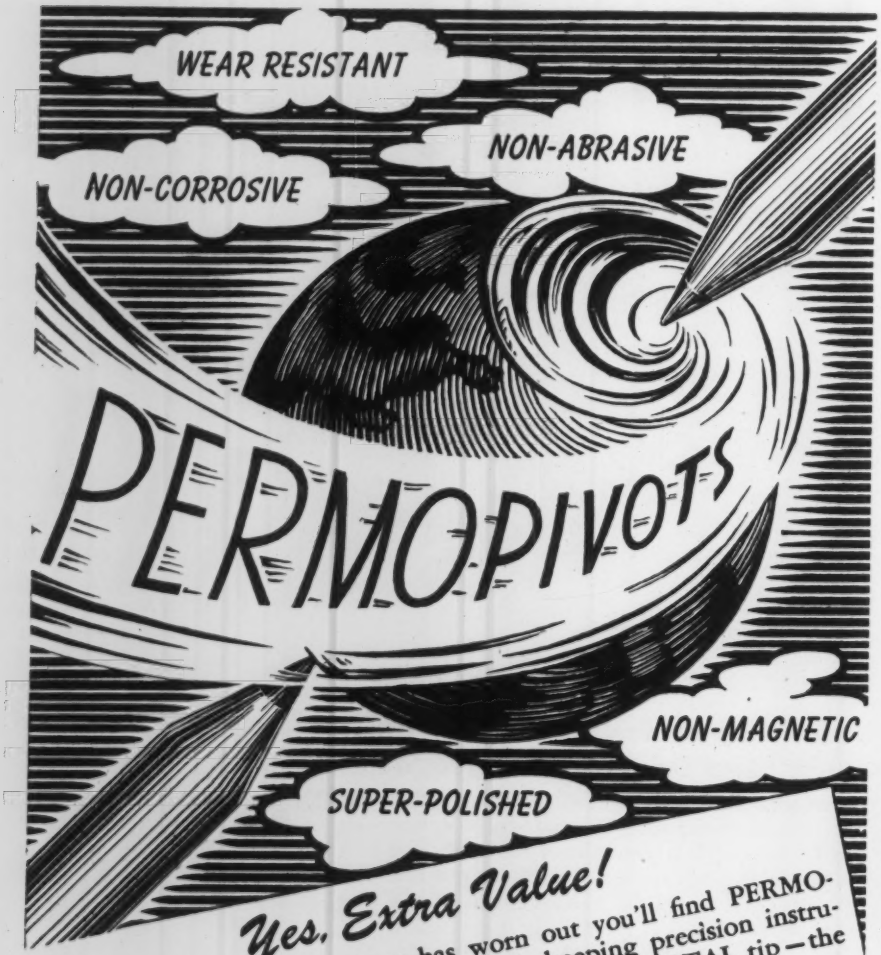
Now you can adjust drill press speeds from high to low—or any intermediate speed—as easily as shifting gears in your car! The Era Variable Speed Drive Attachment enables the operator to provide the correct speed for large or small drills by merely moving a lever. This saving in time results in greater work volume, better work, and lower production cost. **The Era** Attachment fits all popular makes of drill presses, and is easily installed without the necessity of drilling holes or changing present equipment.

To also help save time on the job, many plant owners make chewing gum available to workers. Chewing gum seems to make work go easier, time go faster. Wrigley's Spearmint Gum may be used even when both hands are busy, eliminating work interruptions, and thus promoting greater safety for the operator.

Era Variable Speed Drive

You can get complete information from Era Meter Co. 3940 N. Kilpatrick Ave., Chicago 41, Ill.

AA-203



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Long after the ordinary pivot has worn out you'll find PERMO-PIVOTS in the prime of life—faithfully keeping precision instruments precise! It's all due to the special PERMOMETAL tip—the ideal osmium alloy. . . . Made to your specifications.

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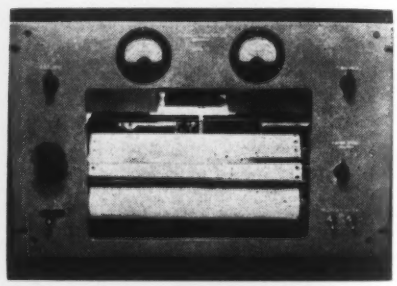
MANUFACTURING METALLURGISTS

a-c. output can be adjusted manually to desired voltage, but it is not regulated. An "OFF" position is also provided, as are indicators for d-c. and a-c. output voltages, and three pilot-lights to show that unit is operating and which output is connected to output receptacle. "Model 310-B" is identical except that d-c. power only is provided at output receptacle. Consequently, the a-c. voltmeter, the variable auto-transformer, the output selector switch and two pilot-lights are omitted. D-c. voltage is continuously adjustable between 0 and 135 volts at 0—450 ma., remains constant within 1% regardless of variations of a-c. power-line voltage and of load current. Ripple and noise: less than 0.025 volt in d-c. output. Fuse on primary winding of power-transformer (short-circuit current is limited to approximately 560 ma.); also, in "310-A," an additional fuse protects the variable auto-transformer. A-c. voltage ("310-A" only) continuously adjustable from 0 to 135 volts at 0—1 ampere. Steel cabinet, 21" wide, 10½" high, 15" deep. Front panel and base can be removed and unit will fit a standard relay rack.—*Furst Electronics, 800 W. North Ave., Chicago 22, Illinois.*

Please mention number 1243 when filling out card

Twin Recorder

New "Twin-Recorder," for making simultaneously two records of the same or different phenomena, is built in rack form, 12¼" × 19". Two synchronous motors are em-



ployed, one for the writing pens and one for the two chart speeds. It has been developed for facilitating studies of: (1) noise and vibration; (2) current and voltage; (3) linear and logarithmic; (4) db and phon; (5) average and r.m.s. value; (6) peak and average value; (7) amplitude and velocity; (8) velocity and acceleration; and of many other combinations. — *Sound Apparatus Co., 233 Broadway, New York 7, N. Y.*

Please mention number 1244 when filling out card

Vibrometer

New "Model 11-B Vibrometer" is an integrated, amplified vacuum-tube voltmeter with a cable-attached search prod. It registers all three types of vibration: displacement, velocity and acceleration, on a calibrated

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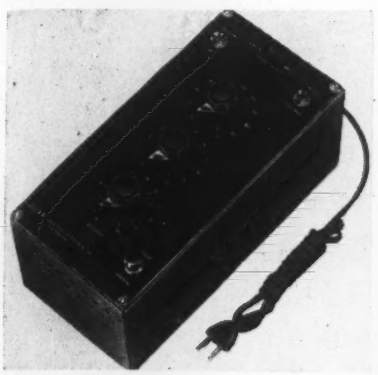
scale. Prod is equipped with interchangeable fittings which permit a wide variety of applications. Instrument weighs 31 lbs., is 17" high, 12" deep and 11½" wide, and has a panel slope of 10°. It operates on 105-125-volt 50-60-cycle supply. With prod attached, frequency response is 5-2500 cps. Five ranges of r.m.s. displacement are measured: 0-.01", 0-.03", 0-.1", 0-.3", 0-1". Five velocity ranges are: 0-1, 0-3, 0-10, 0-30, 0-100 in./sec. Five acceleration ranges are: 0-100, 0-300, 0-1000, 0-3000, 0-10,000 in./sec.^{2}. An output jack is available at rear of Vibrometer for use with phones, oscillograph, wave analyser or recording devices.—*Televiso Products Co., 7466 W. Irving Park Rd., Chicago 34, Illinois.*

Please mention number 1245 when filling out card

Photographic Timer

New "Decade TM-8 Photo Timer" provides 990 time intervals between 1/10 second and 110 seconds in steps of 1/10 second, selected by means of three finger-tip interval

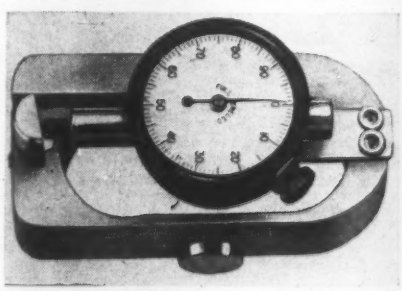


switches calibrated in 1/10, 1 and 10-second units. If desired, "Decade" will automatically reset timing interval. A safe light outlet is provided which operates so that light is on when timer is connected but goes off during the timing interval. Timer can also be operated with a remote control foot switch or through an outlet to platen switch of a printer. Dimensions, 11"×5"×4½". Timer operates on 110-115 volts a.c. or d.c.—*Lektra Laboratories, 30 East 10th St., New York City.*

Please mention number 1246 when filling out card

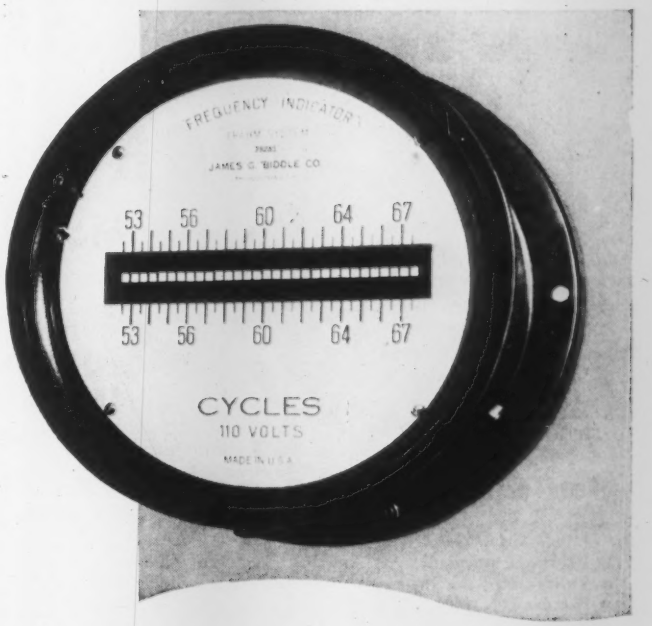
Force Indicator

New "Mechanical Pressure Gauge" is said to represent an advancement in accurate testing work. A precision dial indicator measures deformation of a V-shaped pres-

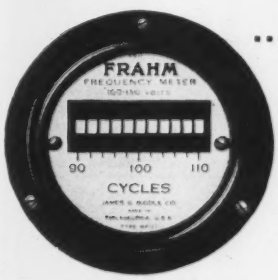


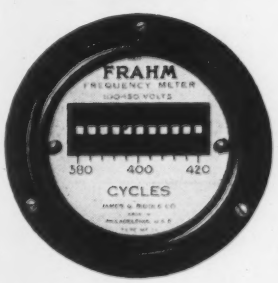
sure bar due to load on center anvils. It is small and lightweight: The 0-100-lb. model measures 3⅝" × 2^{7}/$_{32}$" × 1¾", weighs 1¼ lbs. The 0-250, 0-500, 0-1000-lb. models all measure 4^{5}/$_{16}$" × 2^{7}/$_{16}$" × 2^{3}/$_{16}$", weigh 2 lbs. The 0-2500 and 0-5000-lb. models measure 4⅝" × 2⅝" × 2¾", weigh 2½ lbs. All models are furnished with a strong wooden carrying case. New instrument can be used to check pressure between welding-machine electrodes, between platens in presses, between moving rollers, tension in a moving thread, twine, wire, etc. It works in vises and clamps, can be converted into a

"FRAHM" Frequency Meters



What are your Frequency Measuring Requirements ...25...60...100...400.....1400 cps ?





Frahm Frequency Meters in switchboard, miniature and portable types are regularly available for ranges between 15 and 500 cycles per second.

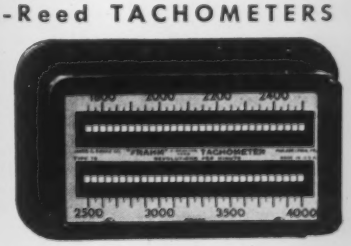
To meet special requirements, our laboratory has designed and built instruments for measuring frequencies as high as 1400 cycles. Such, we find, is possible by means of the same simple and direct resonant reed principle, usually requiring less than 0.1 volt-ampere power input, and without recourse to intermediate frequency conversion equipment. We believe that even higher frequencies are possible.

We invite correspondence regarding any frequency measurement problem in the audio and sub-audio range. For its solution we proffer our instruments, our services and facilities. In our 30 years of association with the resonant reed principle as applied to the measurement of frequency, we have been instrumental in the solution of a surprising variety of problems.

Write for Bulletin 1770-I.

"FRAHM" Vibrating-Reed TACHOMETERS

. . . operate on the same unique principle as Frahm Frequency Meters except that reed vibration is produced by direct mechanical contact instead of electrically. Available in stationary and portable types . . . for use on turbines, generators, motors, blowers, centrifugal pumps, diesel-electric installations, etc. Various ranges from 900 to 100,000 rpm. Write for Bulletin 1810-I.



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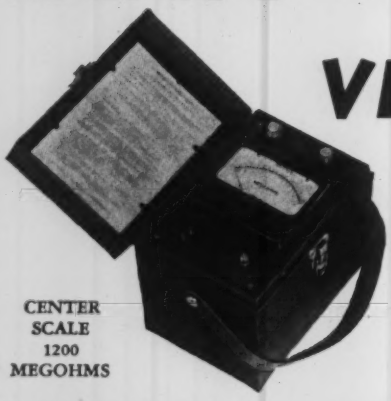
WIDE RANGE
Insulation Resistance Meter
50,000 Megohms

VIBROTEST

Model 261



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Self-contained · Compact · Easily Portable

- Highest accuracy. Hand-stepped scale.
- Calibrates at infinity.
- Voltage regulator in measuring circuit.
- For extreme temperature variations. Tested from 40° below zero F. to 140° F., above.
- NO TIRESOME CRANKING. Has its own dependable power source.
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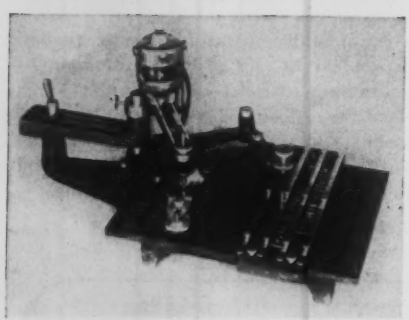

For lettering panels of steel, aluminum, brass, or bakelite, or for making finished apparatus.

Attachments adapt it to small or large work on flat or curved surfaces.

Excellent engraving can be produced by an inexperienced operator.

Widely used for production as well as occasional engraving.

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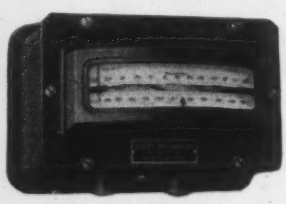
Wall-Type INDICATOR PYROMETER

A PRODUCT OF 40 YEARS OF RESEARCH



Model W-1
Switchboard Indicator

Unskilled help may handle this direct-deflection instrument, which needs no manual adjustment. Designed for numerous ranges of temperature, both F. and C.

Write for descriptive Bulletin 400

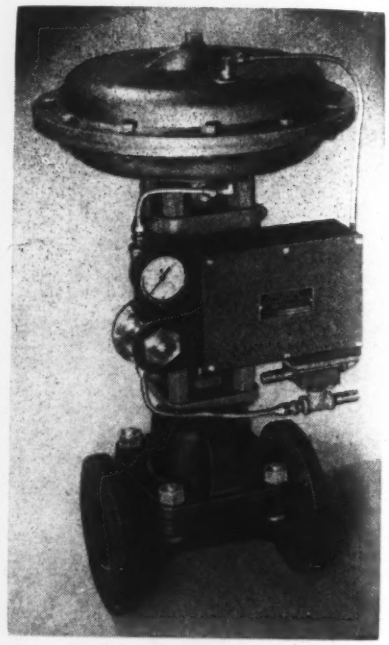
Charles Engelhard, Inc.
233 N.J.R.R. Ave. Newark 5, N. J.

miniature testing machine. It is said to be almost entirely unaffected by extreme temperature changes and can be used indoors or out. In cases where operator cannot get close enough to read the dial, maker can supply remote repeater stations. — *W. C. Dillon & Company, Inc., 5410 W. Harrison St., Chicago 44, Illinois.*

Please mention number 1247 when filling out card

Diaphragm-motor for "Saunders Patent" Valve

New "Springless Conomotor," when mounted on a "Saunders Patent Valve," transforms it into a throttling valve for use



with pneumatic control instruments. "Springless Conomotor" is said to be much more powerful and versatile than a standard spring-and-diaphragm pneumatic motor. By replacing spring of conventional motor with a static pressure-loading system and utilizing a special "Cono-Moore" Valve Positioner, power output is increased, thereby making motor suited for overcoming the large internal forces peculiar to the "Saunders" packless valve.—*Conoflow Corp., 2100 Arch St., Philadelphia 3, Penna.*

Please mention number 1248 when filling out card

Single-knob Type Control for Electric Motors

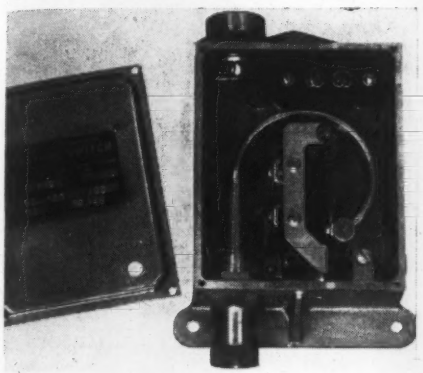
New "Yardeny System Pulsing Drive," for control of reversible electric motors is essentially a switching control with main features centralized in a single knob. It can easily be connected to existing control equipment such as push button stations or automatic motor-starting equipment. It controls

direction of rotation (clockwise or counter-clockwise); slow rotation of knob results in motor rotation in small increments (as little as ¼ turn at a time); fast rotation of knob results in more extended travel of motor (up to full speed); continuously depressing knob results in continuous rotation of motor up to full speed. Duration of basic pulse may be adjusted by a screw. Range of pulse adjustment permits giving desired results even when using commercial magnetic starters. Another feature is "pulse-plugging" to stop motor rapidly by simply turning knob a fraction of a turn in opposite direction.—*Yardeny Laboratories Inc., 105 Chambers St., New York 7, N. Y.*

Please mention number 1249 when filling out card

Pressure Switch

New "Model Series 310" pressure-operated switch may be adjusted externally without removing cover or disturbing mounting. Designed to operate within range of 20 to

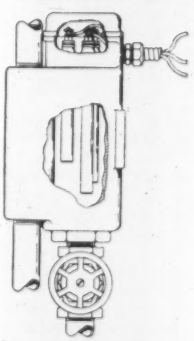


3,000 lbs./in.², it is capable of withstanding excess pressures. All materials are treated to make entire unit corrosion-resistant. Electrical rating is 10 amps. at 125 volts a.c.; electrical connection is for ½" threaded conduit. Pressure connection is ¼" NPT female thread.—*Meletron Corp., 950 North Highland Avenue, Los Angeles 38, Calif.*

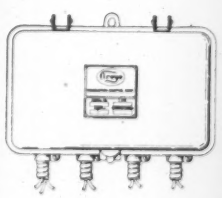
Please mention number 1250 when filling out card

Automatic Boiler Feed-water Controller

New "Fireye Boiler Feedwater Control" consists of "Control Type 15GKI" and "Probe Fitting Type 65BF3." Probe fitting, mounted parallel to water column, contains



TYPE 65 BF3



TYPE 15 GKI

three probes: top and middle probes determine high and low level at which feed-water pump is turned off and on; lowest probe defines danger point below which "Fireye" immediately shuts off fuel supply and sounds an alarm. "Control Type 15GKI" contains no moving parts, no floats or bellows seals, no vacuum tubes. Direct current is used in relay circuit to increase contact pressure and make possible the use of low a-c. voltages in probe circuit. Problem of electrolysis is said to be eliminated. Closure of probe circuit alters magnetic field of transformer

ELECTRONIC SWITCH

TYPE YE-9

FOR THE STUDY OF

- WAVE FORM
- PHASE
- FREQUENCY RELATIONSHIP
- COMPARISON OF AMPLITUDE

AN invaluable instrument in the laboratory, the Electronic Switch will aid in the simplification of many studies of electrical phenomena. Two or more independent signals may be observed on a single oscilloscope, or, by using two YE-9s, three independent circuits can be studied.

Mechanical vibrations, sound, light and other quantities transferable into electrical functions may be compared.

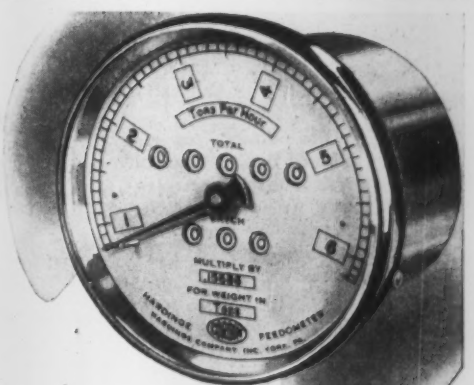
The YE-9 may be used with any oscilloscope having a horizontal sweep voltage and available connections to the plate of the cathode ray tube. No adjustments or calibration are required when the instrument is in use.

Write for complete information to: *General Electric Company, Electronics Department, Syracuse 1, N. Y.*

GENERAL ELECTRIC

164-E3

You're FACE TO FACE WITH ALL THE FACTS



At a glance, the face of this CORBIN Tachometer will tell you the number of TONS PER HOUR, TONS IN BATCH and TOTAL TONS up to that time. Whether you're counting tons or cases, bottles, bales . . . or measuring in lengths, or counting revolutions . . . Corbin can engineer a Corbin Tachometer to meet your requirements.

You can depend on a CORBIN Tachometer to give you the facts *face to face* . . . to respond instantly, operate smoothly without lubrication, and last for years — and years.

No guesswork when you use a CORBIN Tachometer.

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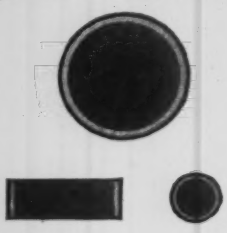
PA-3

Accurate CORBIN Tachometers

BRADLEY

PHOTO ELECTRIC CELLS



Unmounted Cells

The shapes of Luxtron photocells vary from circles to squares, with every in-between shape desired. Their sizes range from very small to the largest required.

In addition to the unmounted cells shown here, Bradley also offers cells in a variety of standard mountings, including plug-in and pigtail types.

For direct conversion of light into electric energy, specify Bradley's photocells. They are rugged, lightweight and true-to-rating.

Illustrated literature, available on request, shows more models of Bradley photocells, plus a line of copper oxide and selenium rectifiers. Write for "The Bradley Line."

BRADLEY LABORATORIES, INC.

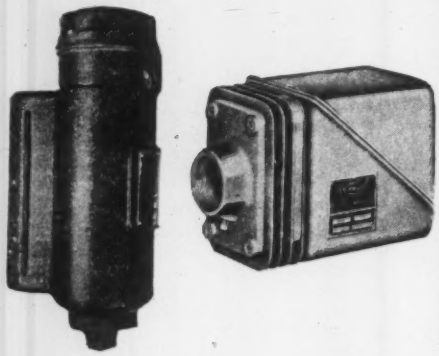
82 Meadow St. New Haven 10, Conn

in such a way that current is generated in the rectifier-relay circuit, energizing the relay. Equipment is available for every make, type and size of steam boiler, with any method of firing and for any pressure up to 300 lbs./in.^{2}.—*Combustion Control Corp., 77 Broadway, Cambridge 42, Mass.*

Please mention number 1251 when filling out card

Combustion Safeguard System

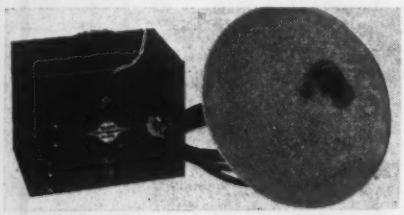
New "Type 818TS Fireye Combustion Control" combines safeguards against flame failure and low boiler water level, is designed to protect commercial and industrial oil-burning equipment. "Fireye" phototube and amplifying system, housed in a dust-tight aluminum case, is mounted on furnace wall and is aligned to permit photocell to observe the flame through a 2" pipe connection which serves as sighting tube and support for the equipment. Equipment protects against dangerously low boiler water level by means of a single probe in auxiliary fitting "Type 65BF1," mounted parallel to boiler water column and wired to "Fireye Control." Units operate on 115-volt or 250-volt 50-60-cycle a-c. supply; consume 10 watts. Ambient temperature range: 32°F. to 150°F.—*Combustion Control Corp., 77 Broadway, Cambridge 42, Mass.*



Please mention number 1252 when filling out card

10,000-flash Photographic Lamp

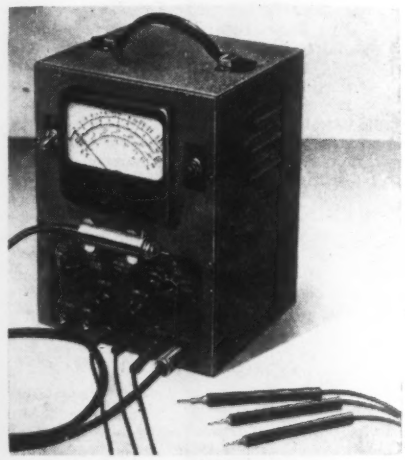
New "A-C. Operated Portable Strobo-Light" has the following features; (1) Uses a "K-60 Sunlight Spectrum" bulb which gives sunlight quality on color work, indoors or out, without filters; (2) Bulb will take 10,000 pictures; (3) Makes possible taking high-speed action shots with an ordinary camera; (4) Light intensity is said to be approx. 100 times that of sunlight.—*Kluge Electronics, Inc., 1031 North Alvarado St., Los Angeles 36, Calif.*



Please mention number 1253 when filling out card

Radio and Electronic Circuit Tester

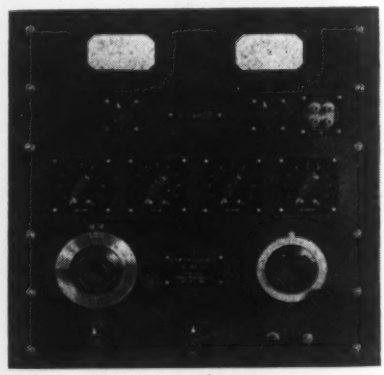
New "Type 134 Polymeter," for testing radio and television sets and many types of industrial electronic apparatus, includes a thumb-size vacuum-tube probe utilizing the Type 1247 proximity fuse type tube; balanced amplifier circuit practically independent of line voltage and normal amplifier tube changes; preset factory adjustments permitting correct zero setting for all ranges through one front panel adjustment. Measurement ranges include: d-c. volts, 0-3, 0-10, 0-30, 0-100, 0-300, 0-1000; a-c. volts, a-f, 20-15,000 cps., 0-3, 0-10, 0-30, 0-100, 0-300; r-f. volts, 10 kc.-300 mc., 0-3, 0-10, 0-30, 0-100, 0-300; d-c. current, 0-3 ma., 0-10 ma., 0-30 ma., 0-100 ma., 0-300 ma., 0-1000 ma., 0-10 amperes; resistance, 0-1000 ohms, 0-10,000 ohms, 0-100,000 ohms, 0-1 megohms, 0-10 megohms and 0-1000 megohms. Cabinet measures approx. 10" high, 18" wide and 6⅞" deep; weighs 16 pounds; and is rated at 30 watts input at 105-125 volts, 50-60 cycles a-c.—*Sylvania Electric Products Inc., 500 Fifth Ave., New York 18, N. Y.*



Please mention number 1254 when filling out card

Low-frequency "Q" Indicator

New "No. 1030 Low-frequency 'Q' Indicator" contains (1) an audio-frequency RC type oscillator, (2) a precision tuning capacitor, (3) a vacuum-tube voltmeter which measures voltage developed across tuning capacitor, (4) a power amplifier to feed signal into resonant circuit, (5) a vacuum-tube voltmeter which measures voltage across tuned circuit. The "Q" of a given coil is measured by resonating the coil with the precision tuning capacitor at a given frequency. At resonance the voltmeter connected across the tuning condenser measures directly the "Q" of the coil. Oscillator frequency range: 50 to 50,000 cps. in four ranges. Oscillator frequency accuracy: ±1%. Range of "Q" measurements: 15 to 500. Accuracy of "Q" measurements: approx. 6% for frequencies from 50 to 50,000 cps. A-c. power consumption: 200 watts. Dimensions: 20" wide × 24" high × 14" deep.—*Freed Transformer Co., Inc., 72 Spring St., New York, N. Y.*

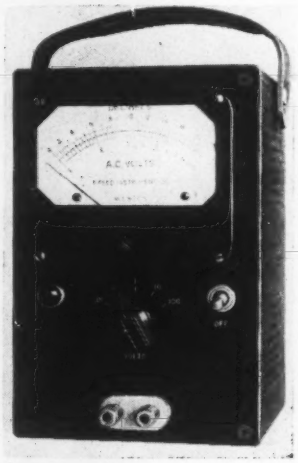


Please mention number 1255 when filling out card

Vacuum-tube Voltmeter

New "No. 1040" vacuum-tube voltmeter has the following voltage ranges: 0.001 volts to 100 volts in 5 ranges (0.01, 0.1, 10, 100 volts full-scale). Accuracy: 2% of full

scale on all five ranges, on sinusoidal voltages. Waveform error: Instrument is a peak voltmeter calibrated to read rms. values on distorted wave-forms; percentage deviation of reading from rms. value may be as large as percentage of harmonics present. Frequency range: 10 to 200,000 cycles, 0.1 db variation from 10 cycles to 200,000 cycles. Input impedance: Equivalent to a 500,000-ohm resistance in parallel with a 10 mmf. capacitor. Stability: Changes with variation in power supply voltage from 100 volts to 125 volts is 1% in effect in changes of tubes less than 0.5%. Accuracy is substantially unaffected by temperature and humidity



conditions over normal range of temperature and humidity variations. Scale: Logarithmic voltage scale calibrated from 1 to 10 plus linear decibel scale calibrated from 0 to 20 db. Indicator: 4" suppressed zero 1 milliammeter protected against overloads. Tubes: Three 6 AU 6, two 6C4, one 6AL5, one 6X4, one OA2. Power supply: Self-contained; operates on 100-125 volts, 50-60 cycles. Dimensions: 5½" high × 5½" wide × 8" long.—*Freed Transformer Co., Inc., 72 Spring St., New York, N. Y.*

Please mention number 1256 when filling out card

Wire Stripper Kit

New "Speedex 733-K Stripper Kit," permits rapid stripping of insulation of any wire from size 8 to 30. It is said that in production, average operators can strip

800 to 1000 wires per hour. "Speedex" and seven interchangeable blades come in a steel case small enough to be carried in a tool box.—*General Cement Mfg. Co., 919 Taylor Avenue, Rockford, Illinois.*

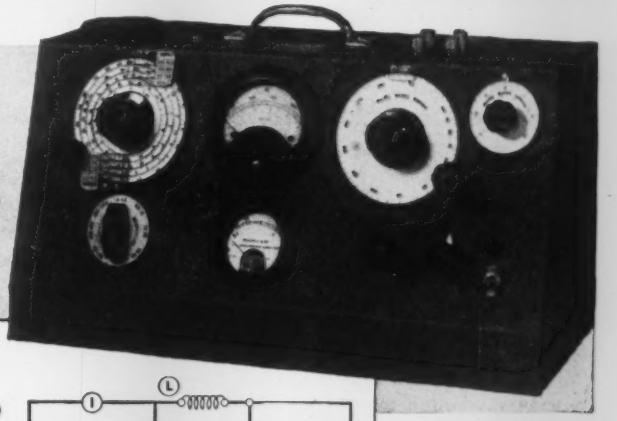
Please mention number 1257 when filling out card

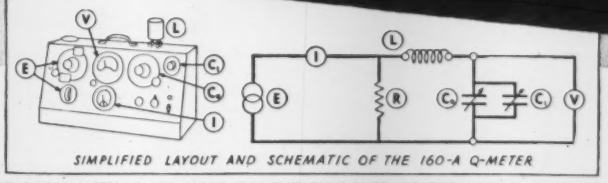
Furnace-humidifier Controller

New furnace-humidifier controller is molded of transparent Tenite allowing visibility of inner mechanism. A scale on cup shows approximate water level to be maintained under different degrees of weather. Controller is located outside furnace casing, connects with furnace-enclosed humidifier by means of a water pipe and an air tube. Water level in controller is same as that of water pan in furnace; air tube assures same static air pressure in sealed Tenite cup as in furnace casing. Air trapped in the cup becomes 100% humidified, and cannot dry to leave a lime residue in controller. Leading into plastic cup through lid is a

MANY FEATURES IN ONE INSTRUMENT

The Q METER
TYPE 160-A





SIMPLIFIED LAYOUT AND SCHEMATIC OF THE 160-A Q-METER

THE BASIC METHOD OF MEASUREMENT EMPLOYED IN THE 160-A Q-METER
An R.F. oscillator (E) supplies a heavy current (I) to a low resistance load (R), which is accurately known. The calibrated voltage across the load resistance (R) is coupled to a series circuit consisting of the inductance under test (L) and a calibrated variable air capacitor (C_0) having a vernier section (C_1). When this series circuit is tuned to resonance by means of capacitor (C_0+C_1), the "Q" of (L) is indicated directly by the V.T. Voltmeter (V). Variations of this method are used to measure inductance, capacitance and resistance.
Oscillator Frequency Range: **50 kc. to 75 mc. in 8 ranges.** ***Oscillator Frequency Accuracy:*** **±1%, 50 kc.—50 mc.** ***Q-Measurement Range:*** **Directly calibrated in Q, 20-250. Multiplier extends Q range to 625.** ***Capacitance Range:*** **Main section (C_0) 30-450 mmf. Vernier section (C_1)+3 mmf, zero, —3 mmf.**

DESIGNERS AND MANUFACTURERS OF
THE Q METER
QX CHECKER
FREQUENCY MODULATED SIGNAL GENERATOR
BEAT FREQUENCY GENERATOR
AND OTHER DIRECT READING TEST INSTRUMENTS

BOONTON RADIO Corporation
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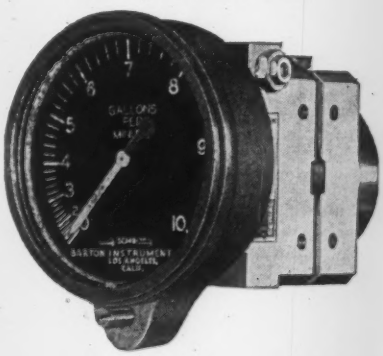
Differential Pressure INDICATOR



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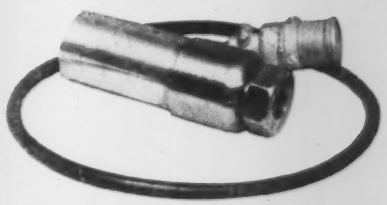
STATHAM PRESSURE TRANSMITTER

MODEL P 10



The Model P 10 Pressure Transmitter, newest member of our line of remote reading instruments, is now available.
Increased accuracy is combined with the simplicity of operation, ruggedness, small size and light weight which characterize all Statham Instruments.

Specifications:
Ranges: 50 psi to 5000 psi.
Input power requirements: Dry cells, regulated A. C. or carrier.
Output: Sufficient for direct operation of panel type microammeters, recording oscillograph, recording potentiometer, or cathode ray oscilloscope.
Size: 1⅜ x 4 in. Weight: 14 oz.

Statham Laboratories also makes Pressure Transmitters with full ranges as low as —0.2 psi, accelerometers, and dynamometers. Our engineering department is at your service to analyze your problem and make specific suggestions for solving them. Write for our catalog.

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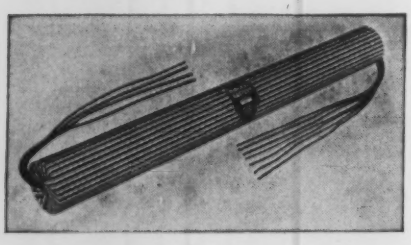
No. 1 of a Series

The problem: To design a battery for deep well Radioactivity Well Logging for the petroleum industry that would meet the rigid physical specifications of the Lane-Wells Company for use inside the well casings. To build a battery that would withstand high temperatures and which would be equipped with special insulated leads with multiple voltage taps.



The solution: an unusual "A & B" battery pack that meets all physical specifications, and which under severe operating conditions, provides 50 to 60 hours of service above the required minimum operating voltages.

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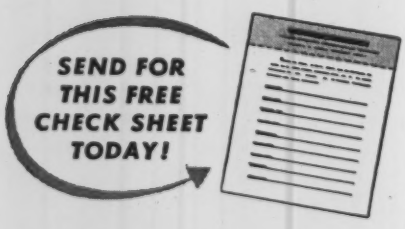
Design • Engineering • Production

...is at your disposal to provide the battery you need in the quantity you require...large or small. Send for free Burgess check sheet that enables you easily to provide Burgess engineers with all information important to the design of a battery for *your* special requirements.



BURGESS BATTERY COMPANY

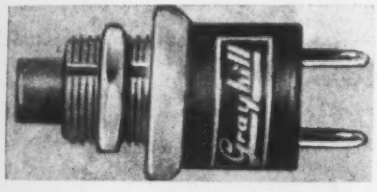
Dept. I-12, Freeport, Illinois

water inlet controlled by a self-flushing diaphragm valve. Rate of drip feeding from this inlet equals rate of evaporation in pan, which is regulated according to desired degree of humidity. Valve automatically closes when water level rises to within 5/8" of top of pan in furnace. If grit is present on valve seat, level rises slightly and surplus goes out bottom of cup through an overflow tube. A coil in this tube provides a trap which prevents exit of air while allowing water to pass. A Tenite bell float maintains water level for which control lever is set. — *Cleveland Humidifier Co., Cleveland, Ohio.*

Please mention number 1258 when filling out card

Push Button Switch

New "Series 4000 Push Button Switch" is said to feature momentary contact with automatic return. Unit has minimum



number of moving parts. Round phenolic base is 0.656" in diameter and 0.625" in depth; plunger assembly protrudes 0.531" in front of base and is enclosed in a bushing which, in conjunction with a hex nut, provides for panel mounting. Switch is rated at approx. ½ amp., 110 volts.—*Grayhill, 1 N. Pulaski Road, Chicago 24, Illinois.*

Please mention number 1259 when filling out card

Pressure Gages

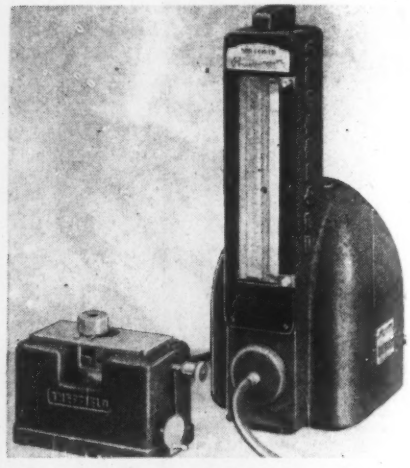
New complete line of pressure gages are of a design said to be "streamlined," with a convex non-breakable crystal, dial lettered in contrasting letters, and a newly designed red-enameled pointer. Bourdon type movement is said to be "constructed

to absorb all shocks from severe uses," gage is suitable for any liquid or gas, and cannot corrode from steam, water, air, etc. Distortion of pressed steel case will not affect accuracy or reading of graduated dial.—*Dayton Rogers Mfg. Co., 2835 12th Ave. S., Minneapolis, Minn.*

Please mention number 1260 when filling out card

Pneumatic Gage for Checking Ring Gages

New "Precisionaire Internal Measuring Instrument" is a pneumatic comparator sensitive to microinches, for checking rings from 5/32" to 1" internal diameter. It also



indicates taper, bellmouth and out-of-round conditions. Rings may be explored to a depth of 9/16" from each side by handwheel vertical adjustment of diamond-tipped gaging arms. Precision gage blocks are used in setting instrument. Amplification is approx. 35,000. Each graduation representing five microinches occupies 0.175" on scale. New internal comparator is said to be "ideal for the gage control room."—*The Sheffield Corp., Dayton 1, Ohio.*

Please mention number 1261 when filling out card

Instrument Transformers

New models of transformers can be produced to specifications in a range of capacities from 10 va. to 75 va. Illustration shows a 15-va. transformer mounted on a 4" box

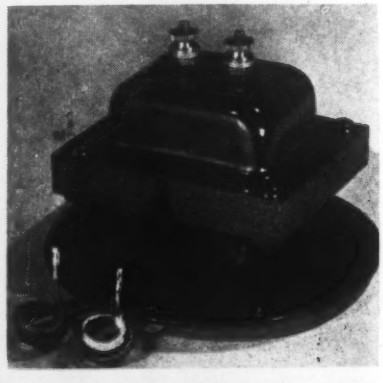
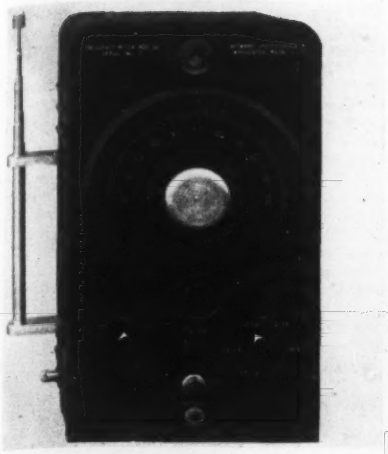


plate. Announcement states that new transformers are ruggedly built and conservatively rated.—*Standard Electrical Products Company, 400 Linden Avenue, Dayton 3, Ohio.*

Please mention number 1262 when filling out card

Frequency Meter

New "Model S-6" general-coverage frequency meter, for continuous frequency range of 100 kc. to 50 Mc., features ± 0.025% accuracy, 6" dial readable to one

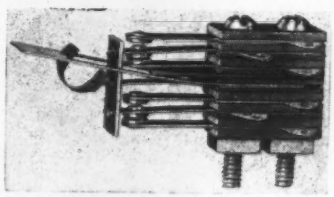


part in 1000, transformer-type power supply. Oscillator range of 1.0 to 2.0 Mc. in five bands, each tuning 200 kc., and built-in crystal calibrator. External signals are coupled through a telescoping antenna which also serves as a carrying handle. Dimensions: 13½" × 7⅝" × 6⅞". Weight: 15 lbs.—*Browning Laboratories, Inc., 742-750 Main Street, Winchester, Mass.*

Please mention number 1263 when filling out card

Snap-action Switch

New snap-action open-blade switch, for 2-pole applications, features maker's patented "Beryllium Rolling Spring," is avail-

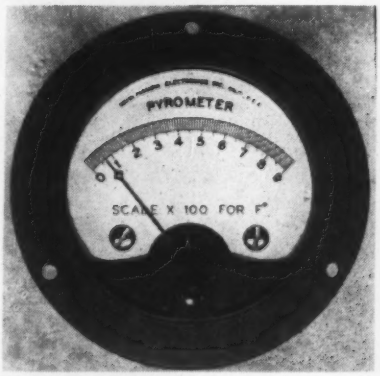


able with both single- and double-throw contacts. Standard operating pressures are from 3 to 5 oz. Furnished with terminals as illustrated, or at the rear. Dimensions, 2⅛" × 25/32" × ⅜". Rated at 15 amps., 125 volts a-c. with a movement differential of approximately 1/16".—*Acro Electric Co., 1324 Superior Avenue, Cleveland 14, Ohio.*

Please mention number 1264 when filling out card

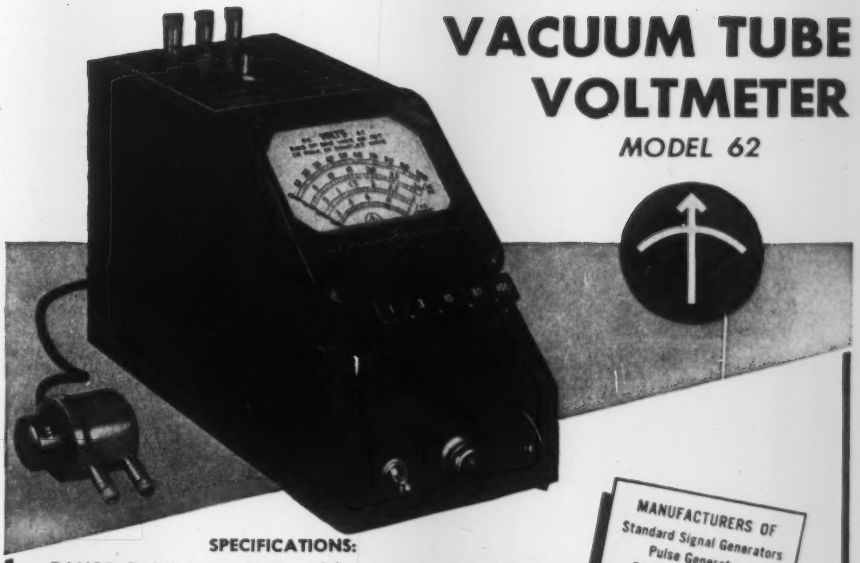
Indicating Thermoelectric Pyrometer

New "Gem" pyrometer can be used either as a portable or panel-mounted instrument. Flush type Bakelite case is 3½" in diameter, sealed against dust, ordinary moisture and fumes. It has a 2¼" seale which can be graduated with as many as 100 lines if necessary. Instrument can be furnished in any standard range, from 0—3000° F. (or Centigrade equivalents) and calibrated for any of the standard base metal or rare-



VACUUM TUBE VOLTMETER

MODEL 62



SPECIFICATIONS:

RANGE: Push button selection of five ranges—1, 3, 10, 30 and 100 volts a.c. or d.c.

ACCURACY: 2% of full scale. Useable from 50 cycles to 150 megacycles.

INDICATION: Linear for d.c. and calibrated to indicate r.m.s. values of a sine-wave or 71% of the peak value of a complex wave on a.c.

POWER SUPPLY: 115 volts, 40-60 cycles—no batteries.

DIMENSIONS: 4¾" wide, 6" high, and 8½" deep.

WEIGHT: Approximately six pounds. *Immediate Delivery*

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Standard Signal Generators
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Quantity buyers! MID-AMERICA has 70,000 square feet of warehouse space jam-packed with radio parts, electronic equipment, etc. Items at UNBELIEVABLY LOW PRICES—that will save and make you money. Listed below are a few samples!
Universal Output Transformer will match voice coil to any tube, single or push-pull. Strap mounting on 2⅞" centers. Size: 2¼" high, 2" wide, 2" deep. Minimum order—100 98c each
AC-DC CHOKE 15 henry, 50 MA, 120 ohms DC resistance. Size: 1½" x 2" x 1½" Minimum order—50 59c ea.
ACORN TUBE SOCKET Low loss ceramic socket with rugged spring contacts for 954 and 955 tubes Minimum order—100 $7.50 Per 100
SPEAKERS
5" Alnicko V PM Speaker with 4 ohm voice coil, less output transformer. Minimum order—100 $1.37 ea.
6" Alnico V PM Speaker with 2.15 Alnico V slug. Minimum order, 100 $1.79 ea.
PL-68 PLUG Jack Set with 4 ft. of 3-conductor rubber-covered cable with PL-68 plug on one end and 3-way open circuit jack, at other end. Minimum order—100 15c each
10 Watt RESISTORS — any ohmage — per size or assorted Minimum order—100 $7.00 per 100
GUARANTEED
All items shown in this ad are guaranteed as rated by nationally-advertised manufacturers and are new, unused and in perfect condition.
Milliammeters—GE & Westinghouse
0-300 MA DC, 2¼" flange, 2⅛" dia. body, 1½" deep.
0-20 MA DC, 2¼" flange, 2⅛" dia. body, 1½" deep. Both types with white scale, black markings. (Minimum order each type—10.) $1.95 ea.
RELAYS—Write for 12-page book illustrating more than 250,000 relays. 24c each, and up.
DYNAMOTORS—79c, and up! Write for complete listing of dynamotors. Our prices will 'shock' you!
APC CONDENSERS—$c each, and up! We have large quantities of unused APC condensers—all at ridiculously low prices! Ask for special condenser listing!
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TERMS: We extend usual credit to rated accounts. Others send 25% with order, balance C.O.D. All prices shown are f.o.b. Chicago warehouse.
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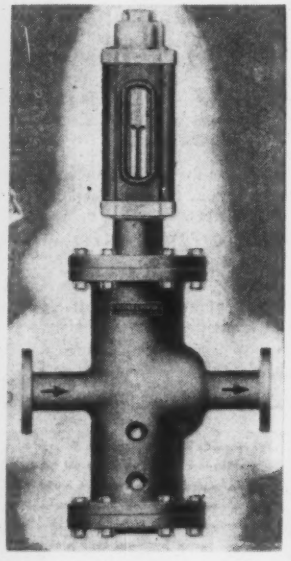
metal thermocouples. Internal resistance is 10 ohms at 10 mv. Automatic internal cold-end compensation can be furnished if desired. Announcement lays stress on fact that instrument does not have an ordinary electrical instrument movement converted to pyrometric use, but has a specially designed movement built in company's own plant for temperature measuring. — *Electronics, Inc., 915 So. Meridian Ave., South Pasadena, Calif.*

Please mention number 1265 when filling out card

Armored Rotamers

New "Series 400" models of maker's rotameters are available for pressures up to 600 lbs./in.^{2} (at 100°F.) or 300 lbs./in.^{2} (at 800°F.), with horizontal line connec-

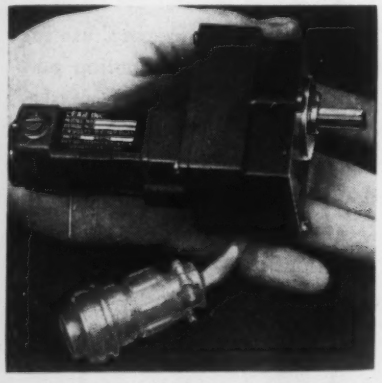


tions (like a globe valve, as illustrated), with vertical upward inlet and horizontal outlet, or with horizontal inlet and vertical upward outlet. Safety feature is small clearance between float extension and passage leading to sight-glass from meter body: in case of sight-glass breakage, "only a fine steam of fluid can discharge through the passage. Effective scale length is 127 mm., but a full 10" (250 mm.) can be furnished if desired.—*Fischer & Porter Co., Hatboro, Penna.*

Please mention number 1266 when filling out card

Power Units

New "Model 182 Series Rotary Actuators" are applicable to operation of valves and precision positioning for aircraft com-

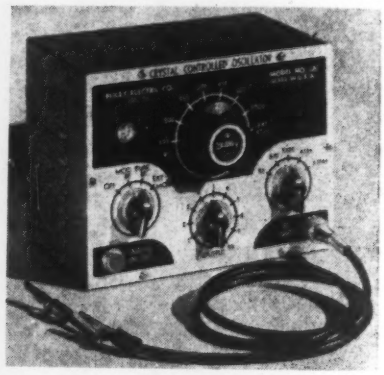


ponents, industrial instruments, computing machines, etc. Over-all length is approx. 5". Worms, worm gears, and helical gears are housed in a compact shell. Maker's "A" or "G" frame motor with integral electromagnetic disk type brake is said to insure precision control. Control equipment is extremely flexible: multiple non-reversing rotary limit switch may be incorporated for any number of positions up to 16; multiple reversing rotary limit switches for any number of positions up to 8. Other features available to meet specific applications are variations in output shaft, over-all gear reduction, motor power rating and availability with or without radio noise suppression, thermal protection, or position indicating transmitter. Weight range varies from 1.25 to 1.75 lbs. depending upon combination of features mentioned. Torque output rating, depending on combination of motor size and over-all gear reduction, varies between 15 and 65 pound inches. New units are available with various speeds and operating torques, can be built to specific requirements involving varying stack lengths, shunt, series or compound windings, with or without brake or clutch, and for intermittent or continuous duty.—*Lear, Inc., Grand Rapids, Mich.*

Please mention number 1267 when filling out card

Crystal-controlled Oscillator

New "CCO" crystal-controlled oscillator, for radio servicing, etc., employs maker's low-temperature-coefficient quartz crystals, stable to within ± 0.1%, to provide instant

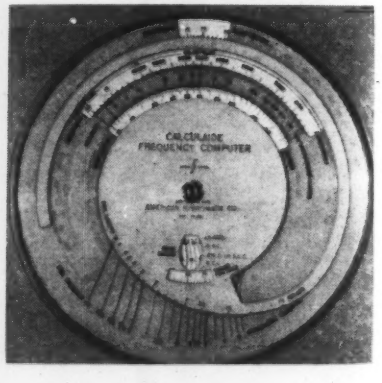


selection of five commonly-used intermediate frequencies: 175, 262, 370, 455 and 465 kc. Direct crystal control is also provided at 200 kc. for r-f. alignment and at 1000 kc. for short-wave alignment. An external socket is provided to accommodate special frequencies that may be required. A three-position modulation selector and a five-step attenuator with vernier output control from 0 to 15 volts are provided. Power consumption is 17 watts at 110 volts. No warm-up period is necessary since crystals are on frequency as soon as oscillator is energized. — *Bliley Electric Co., Erie, Penna.*

Please mention number 1268 when filling out card

Resonant-circuit Computer

New "Calculaide Frequency Computer" solves problems involving frequency, inductance and capacitance. All answers are given at a single setting. Range covers frequencies from 400 kc. to 150 Mc. and wave-lengths from 2 to 600 meters; capacitances between 3 and 1000 microfarads;

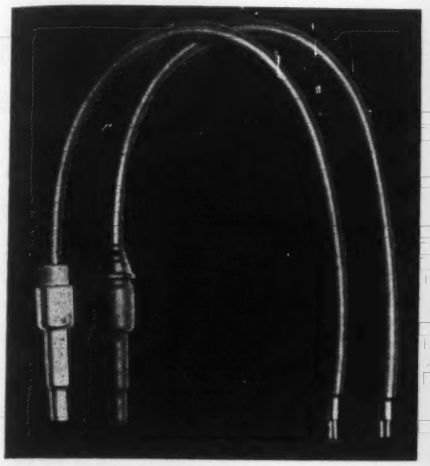


inductances from 0.1 to 1500 microhenrys. Device performs calculations with coils of ¼" to 5½" diameter, ¼" to 10" length, 2 to 150 turns per inch, of No. 10 to No. 35 gage wire, whether enameled, single or double silk covered, single or double cotton covered. Computer is made of non-warping "Vinylite" plastic, 6¼" in diameter. — *American Hydromath Company, 145 West 57th Street, New York 19, N. Y.*

Please mention number 1269 when filling out card

Thermostat for Battery Chargers

New "Type MI" immersion-type thermostat was particularly designed for close temperature control on quick battery



chargers where overheating will ruin a battery. It is also applicable for controlling the temperature of strong liquids, gases and hot plates. It is normally supplied with a neoprene sleeve for applications injurious to brass. Electrical rating is 1000 watts, 110 volts a.c., non-inductive. On-off differential is 3° and control is adjustable within range of 0° to 250°F.—*United Electric Controls Company, 71 A Street, South Boston, Mass.*

Please mention number 1270 when filling out card

Controlled-temperature Quench Tank

New controlled-temperature quench tank, for use by plastics industry for production of extruded plastic threads and other plas-

tic materials, has refrigeration compressor and motor, also motor-driven water pump, installed below tank. A single-pen recording controller, with 20°F. to 200°F. range, is mounted on front panel. Switches for compressor motor, pump motor and controller are located on front panel. A float valve controls flow of fresh water to the bath and a drain valve is furnished for clean-out purposes. A drip pan around entire bath is integral with unit and all plumbing is of copper and brass. New units

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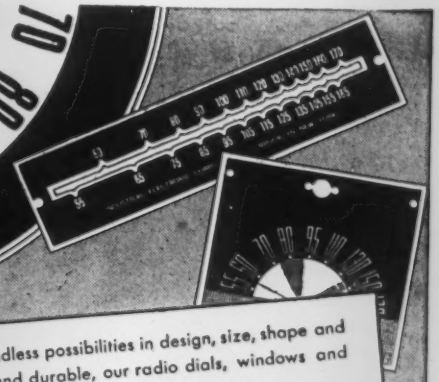

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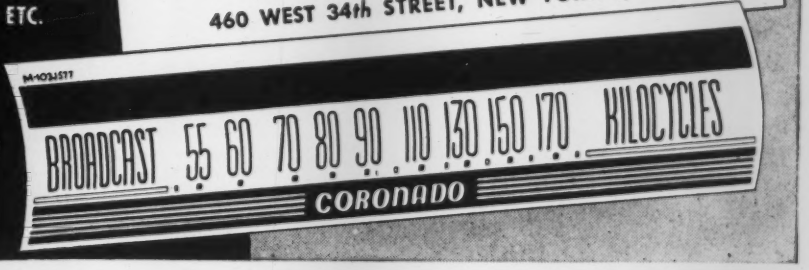

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Unique construction enables operator to rapidly determine temperature even on minute spots, fast moving objects, or smallest stream; no correction charts, no accessories, no maintenance expense. Special "FOUNDRY TYPE" and "Universal TRIPLE RANGE" have, in addition to standard calibrated range, a red correction scale determining TRUE SPOUT and POURING TEMPERATURES of molten iron and steel when measured in the open.

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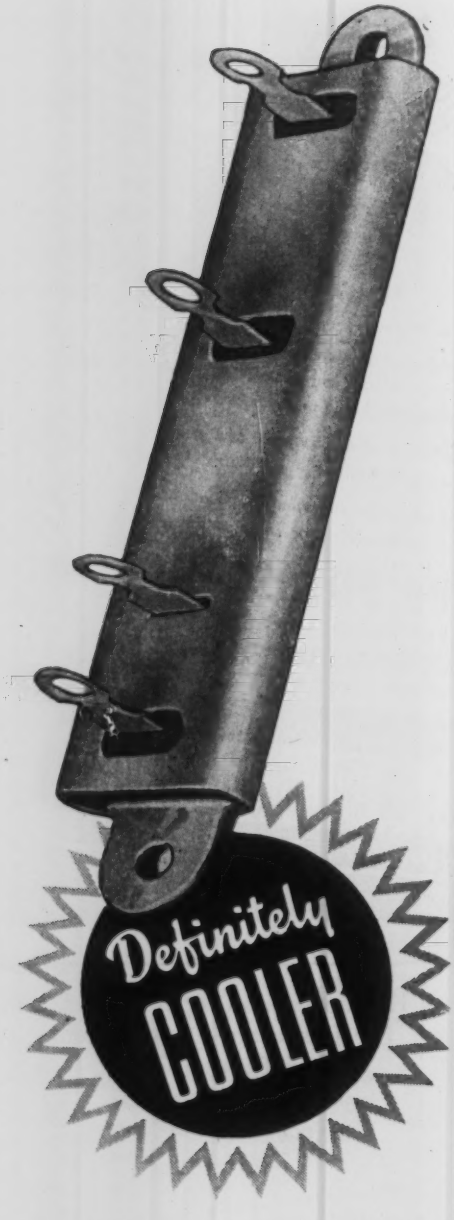

★ **Here's where we go on record: Clarostat Series MMR bakelite-insulated metal-clad resistors are definitely COOLER than any other similar types, SIZE FOR SIZE; or putting it another way, these resistors will DISSIPATE MORE POWER for the same temperature rise, SIZE FOR SIZE. ★ That's our statement. We invite your own tests. ★ Sample on request, if you write on business letterhead. Also detailed literature.**

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CLAROSTAT MFG. CO., Inc. · 285-7 N. 6th St., Brooklyn, N.Y.

are made in various sizes, capacities, and temperature ranges.—*Tenney Engineering, Inc., 26 Avenue B, Newark 5, N. J.*

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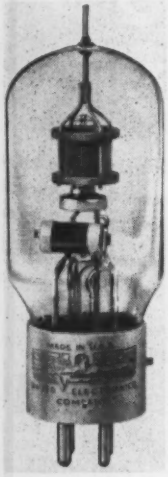
Graphite-anode Beam Tube

New "Type 5562" graphite-anode beam tetrode is for VHF bands of aeronautical, mobile and emergency services. It is conservatively rated at 175 watts input up to 120 Mc. and has low drive characteristics — from 2 to 4.5 watts dependent upon plate input, frequency and class of operation. It contains maker's new "Isolated Getter Trap." Emission and gas content qualities of maker's Graphite Anode Tubes are said to be far superior to tantalum and other comparable metal anode tubes. Characteristics: Filament 6.3 volts at 3. amps.; Amplification factor 60; input to plate capacitance 0.2 mmfds.; d-c. plate voltage 1250 volts and plate current 100 ma (class c); plate input 125-175 watts; Plate dissipation 35 to 45 watts.—*United Electronics Co., 42 Spring St., Newark 2, N. J.*



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Vehicle Accelerometer

New "Performeter," is a pendulum type accelerometer for measuring braking action and "pick-up" of motor vehicles. It is self-contained, requires no electrical or mechanical connections to motor or other parts of vehicle, can be mounted in an automobile in less than two minutes.—*Metron Instrument Co., 432 Lincoln St., Denver 9, Colorado.*

Please mention number 1273 when filling out card

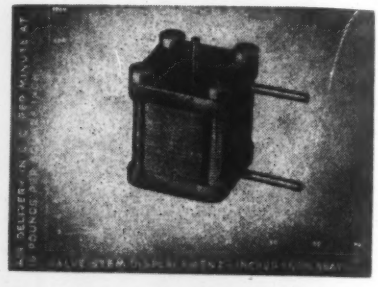
A-c. Voltage Regulator

New "Model D-500" a-c. voltage regulator is for a frequency range of 360 to 500 cps., for aircraft use and general industrial application. It employs light-weight Fosterited transformers and is hermetically sealed to withstand climatic conditions. Other data: Input voltage range 95-125, output voltage range 116-120; load range 50-500 va.; regulation accuracy 0.5%; harmonic distortion less than 5% on special request, otherwise may run as high as 15%; independent of frequency variation up to 10%; transient recovery time approx. 0.1 sec.; unit designed to withstand ambient temperature range of —55°C. to 70°C. Weight 12.5 lbs. Additional models with greater power ratings can also be provided. —*Sorensen & Co., Inc., Stamford, Conn.*

Please mention number 1274 when filling out card

Adjustable-capillary Valves

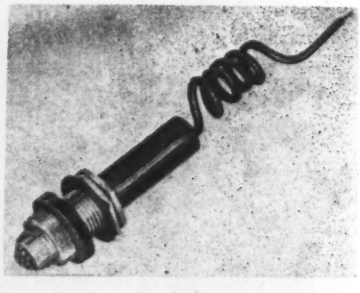
New models of "Micrel Valves" have been redesigned to make them more compact and to give a greater range of flow control. Valves are said to use a "basically new principle to obtain ultra precise and continuous control of either liquids or gases." 500" of capillary passage are contained in valve 1 1/16" square by 1¼" high and flow control is obtained by moving adjustable plunger, thereby varying length of capillary passage continuously from 4" to 500". Gas flow may be varied over range of 2 cc. to 1000 cc. with a pressure drop of 15 lbs./in.² across valve; liquid flow from 0.04 cc. to 10cc. per minute. Air delivery curve at 15-lb. drop is illustrated. New valves shown above will withstand vibration and mechanical abuse, are made of non-corrosive metals and with normal usage will not require replacement of parts. —*Standard Instruments Co. 15 Elkins Street, South Boston 27, Mass.*



Please mention number 1275 when filling out card

Self-flashing Pilot Light

New pilot light indicator incorporates a self-timing flasher which causes light to blink at a rate of 60 to 80 times per minute when lighted. Entire assembly including timer, lamp and housing is 3½" long with flange diameter of 1¼". It mounts on any panel in a single 13/16" diameter hole; has a threaded shank with ¾"-16 nuts to clamp panel. Housing is Bakelite. Flashing action is produced by a sealed glass-enclosed hot-wire type unit designed for extremely long life but which can be replaced as easily as changing a fuse. Current consumption of complete unit, including lamp, is 200 ma. It operates on d.c. to 32 volts, or a. c. to 125 volts with external resistor of 500-ohm 25-watt rating. —*Engineering Associates, 380 Main St., East Orange, N. J.*



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Journal of the Instrument

Editor, R. R. PROCTOR, 2213 Ridge Ave., Evanston, Ill.

SOCIETY OF AMERICA

Vol. 1 DECEMBER 1946 No. 3

Editorial

EMPLOYMENT REGISTRATION

One of the many ways in which a national organization such as ours can be of concrete assistance to its members and to industry is to furnish an employment service and administer it actively and efficiently. The Instrument Society of America has such a service, admin stered by the Employment Registration Committee under the chairmanship of Mr. C. F. Goldcamp of Instruments Publishing Company, Pittsburgh.

In the November issue of the Journal, several "Positions Open" were listed. If the quantity as well as the quality of these openings is any criter on, "Cy" Goldcamp will have his hands full after his committee has had the benefit of a little more publicity such as this editorial is supposed to provide.

So that all ISA members as well as other readers of these columns, prospective employers as well as those seeking employment, may know more about the facil ties of this service, we are listing herewith some of the aims and functions of the Employment Registration Committee. The accomplishments will be reported in these columns as rapidly as they become facts.

The committee is in the process of formation. Mr. Goldcamp has requested each Section to appo nt a local Employment Committee, the chairman of which is to be a member of the ISA Employment Registration Committee. Mr. Goldcamp's activities will be directed toward the operation of the "Central Registration Bureau" which is to serve as a clearing house or liaison center.

The function of each Section committee will be to—

1. Contact the members of that Section and make known the availability of the Central Registration Bureau to possible employers in the territory embraced by the Section, and to urge prospective employers to register their "Positions Open" with the Bureau.

2. Urge those men (members and nonmembers) who are trying to locate positions to register. Registration forms will be provided to the Section's Employment Committee chairman for this purpose. Registration of non-members should be reported to the Section Membership Committee for follow-up.

3. The importance of instrumentation in industry should be sold by the Employment Committee whenever possible so as to create more and better jobs for instrument engineers and instrument technicians. Section publications provide an excellent medium for such groundwork.

The Central Bureau will serve as a clearing house for employers and those seeking positions. The employers as well as the applicants will be classified so that, with a minimum amount of delay, the records of those men qualified to fill the posit ons open can be forwarded to the employers. At the same time the applicants will be notified that their records have been sent, and to whom.

All activities of the Central Bureau will be reported to the Editor of the Journal for publication, and an up-to-date list of positions open will be published n each issue if possible. Fortunately for all of us, Mr. Goldcamp's connection with Instruments Publishing Company will assure that this list *will* be up-to-date as of press time for each issue.

The only requirements to be made by the Section Employment Committee is that the registrants, both employers and applicants, keep the Central Bureau informed of any change of address, or of a pos tion filled or obtained, so as to avoid needless effort by the Central Bureau and enable the files to be kept up-to-date and effective. It can be appreciated that the sending of a man's record to a prospective employer when that man has already secured satisfactory employment, either through the activities of this committee or through his own efforts, will have a tendency to injure the prestige of the Society in the eyes of the prospect ve employer.

It is our hope that many will take advantage of this service, and that through the activities of the Employment Registration Committee, plus the publicity which will be g ven the committee in the columns of the Journal, industry will become increasingly conscious of the importance of instrumentation and of the high caliber of the Society personnel.—RRP

EDITOR'S NOTES

1. CONSTITUTION AND BY-LAWS

In this issue we are publishing for the first time generally the Constitution and By-Laws of the Instrument Society of America. These documents were originally drafted, then corrected, rewritten and improved many times during the last two years or so, by such able men as M. H. White, chairman (Philadelphia), A. H. Shafer (Pittsburgh), Harry F. Moore (New Jersey) and others. (Harry Moore, about whom we shall hear more in a later issue, is the newly appointed chairman of the Constitution Committee.)

Several amendments have been voted upon and included in both the Constitution and the By-Laws since their adoption (by ratification by the Sections) about a year ago. As published in th s issue, both are now in the form approved by the Board of Directors on September 15, 1946.

It is to be hoped that every member will read and become familiar with these articles, for it is only through such knowledge that the members will understand the foundation upon which their Society is built and the basis upon wh ch the business and affairs of the Society are conducted.

2. JOURNAL MATERIAL

The response to your Editor's requests for information and special material has been most gratifying, and we take this opportunity to thank the various Section Secretaries, Delegates and Correspondents for their cooperation. As of this date (November 20, 1946) we have received replies from 61 percent of the requests for l stings of Section officers and delegates. Fourteen of the Sections have appointed Journal Correspondents, with whom we have already been in contact and who are now familiar with our proposed program and future Journal policies. Seventeen of the Sections have sent us the names of their delegates. We now have the names of all but one Section secretary. Whereas thirteen Sections furnished us Section News material for the November issue, nineteen responded for this issue!

The more material received, the more will be published. Those Sections which so far have not returned the questionnaire form listing officers, delegates, correspondents and other Section data will improve their position in the ISA structure if they w ll do so immediately. We appeal to them once more to coöperate with us to help build up the Journal as well as the Society as a whole. It is our intention to publish a roster of key Section personnel in the next issue if possible, and for each Section to be represented we must have the information requested during the past two or three months. (Section officers, please note!)

3. THINGS TO COME

In the last issue (November), some plans for the future were outlined. Since then we have practically worn out a portable typewriter and a Ditto machine firing out requests for material. Sufficient material has come in since then to definitely assure the success of the Journal if it turns out to be the type of thing ISA members desire. At least it w ll fill pages!

In the January issue we hope to start our series of "Who's Who in the ISA," and also to publish our first technical paper—one which was presented at the Pittsburgh Conference.

We haven't as yet received any suggestions from the readers as to what they would like or how to improve the Journal. We will welcome such suggestions, but it is only fair to warn prospective "suggestors" that your Ed tor reserves the right to quote from or

publish verbatim any such letters he receives unless specifically requested not to do so.

4. JOINT MEETINGS

As evidence of the coöperation between Sections of the ISA and between ISA Sections and other societies, there are no less than four joint meetings mentioned in the Section News Department this month! Two of these were jo nt meetings between adjacent ISA Sections (New York—New Jersey and Chicago—Northern Indiana) while two were joint meetings between ISA Sections and other societies (Charleston and Tennessee).

We would like to see more of such meetings. There is no questioning the fact that the larger the crowd which can be expected at a given meeting, the easier it is to secure more prominent speakers, and the more prominent the speaker, the larger the crowd will be. In what better way can membership be increased? Program chairmen, give this idea some consideration!

5. THE NEEDLE POINTS TO—

In each issue from now on, your Editor is going to select one or two Section News write-ups for special attention by all readers. The selected article will be given this extra plug because of its excellence as a Section News report, or its novelty, or for some other characteristic which deserves special consideration. We do not want to play favorites, but if one or two Sections cons stently get "The Needle" issue after issue, it should be an incentive for some of the others to try for the same recognition.

In this issue, the Needle points to

Charleston — for news value and timeliness

New York—for novelty

St. Louis—for detail (unedited report)

Try to swing the Needle your way next time, won't you?

—R. R. PROCTOR

General News

OUR SOUTH TEXAS SECTION

We have before us a letter from Mr. Homer C. Givens, Secretary of the South Texas Instrument Society, which Society will become the South Texas Section of the Instrument Society of America on January 1, 1947. Since this letter is of particular interest and very timely, we are herewith quoting the high spots.

. . . as per your request, here is the list of officers:

President, B. F. Heye, Central Power & Light Company, Corpus Christi

1st Vice-President, T. M. Hunt, U. S. Naval Air Base, Corpus Christi

2nd Vice-President, Jen P. Nielsen, LaGloria Corporation, Falfurrias

Treasurer, F. L. Michael, U. S. Naval Air Station, Corpus Christi

Secretary, Homer C. Givens, LaGloria Corporation, Falfurrias

Chairman Program and Entertainment Committee, L. J. Lynch, Southern Alkali Corporation, Corpus Christi

Delegate, None elected yet

Meetings—Occasionally dinner meetings, usually not. Meetings in Central Power & Light Co. Auditorium, Corpus Christi, second Tuesday of each month.

The South Texas Instrument Society was organized one year ago in November. At present we have seventy-eight (78) members, and have been granted a Charter as a Section of the ISA beginning January 1, 1947.

Our membership comprises a diversified group, probably more so than any other one Section. Gas cycling, oil refineries, vitamin processors, fruit and vegetable canners and packers, aircraft instrument repairmen (including ladies), jewelers (one lady), instrument repair companies, automotive instrument men, typewriter and calculator service men, sales engineers for most instrument manufacturers, vocational school instructors and students, several kinds of chemical plants, electric power companies and construction companies are all represented in our group.

While our meetings are held in Corpus Christi, Texas, most of the time, slightly less than half of our membership comes from an area surrounding Corpus Christi within a radius of about one hundred miles. The Second Vice-President and myself live 80 miles out!

Although we have quite a large membership, we are not a wealthy group as we have no one on our membership list who is well known outside our area. Some of the members make a small sacrifice when they pay their dues. Therefore, you will not see many or any of us at meetings held any great distance from Corpus Christi.

. . . As soon as our elections are held (now in process) our Journal correspondent will send you additional information.

(Signed) Homer C. Givens, Secretary.

Our thanks to Mr. Givens for this informative letter, and again our heartiest welcome to the South Texas Section.

News of Sections

BALTIMORE

The November meeting of the Baltimore Section was held in the auditorium of the Engineers Club of Baltimore on Friday, November 1, with Mr. Harry Kessler presenting a most interest ng lecture, illustrated by slides, on "Automatic Boiler Controls". His talk and the ensuing discussion dealt with the fundamentals of combustion control, boiler water level control and other related topics.

A social get-together, enhanced by cocktails, preceded the dinner, and refreshments were served after the meeting adjourned.

—H. L. HALSTEAD, *Sec'y-Treas.*

CALIFORNIA

Following is a list of the 1946 officers and national delegate of the California Section: President, H. H. Cary; Vice-president, R. P. Gallien; Treasurer, Fred Cole Jr.; National Delegate, James A. Broadston.

The California Section was addressed by two speakers at the regular meeting on November 5th. One of the speakers was Mr. Robert W. Fulwilder, a member of the Californ a Section and a practicing patent attorney, who spoke on "Patents from the Engineer's Viewpoint." Mr. Fulwilder covered the broad question of when and whether to obtain a patent, what can or should be patented, how to go about it, employer and employee relationships with respect to patent ownership, infringement, what a patent permits, and other points of great interest to the research man and the development engineer.

The other speaker was Dr. Burke of the Reconstruction Finance Corporation, Division of Rubber Reserve, who is in charge of specifications of raw materials and products made in the Government-owned synthetic rubber plants.

Dr. Burke gave a brief outline of the problems of instrumentation in synthetic rubber manufacture, and told of the various needs for improved instruments for numerous applications. He pointed out that there is a definite opportunity for instrument manufacturers and instrument development engineers to assist in creat ng new and improved types of instruments which perhaps would have application in the chemical and other industries as well.

Our next meeting will be Tuesday, December 3rd, which will be held at Eaton's Ardmore Cafe, 3550 Wilshire Blvd. Mr. Don O. Kocmich, Sales Manager of the Tr mount Instrument Company of Chicago, is to be the speaker, and his subject will be "Dynamic Pressure Measuring Equipment."

—M. D. PUGH, *Corr.*

CHARLESTON

(Received too late for the November issue)

At a joint meeting of the Charleston Section of the Instrument Society of America and the West Virgin a Section of the American Society of Mechanical Engineers on November 4, 1946, Mr. C. B. Cochran, president of the Charleston Section of ISA, presided and introduced to an audience of over 150 the officers of the West Virginia Section of ASME.

A short ISA business meeting followed, at wh ch John Steven, chairman of the nominating committee, presented the following slate of nominees: for President, Francis E. James and Marvin B. Lorig; for Vice-president, Charles G. Fellows and Louis F. Keppler; for Secretary, Carl Cavender and Stewart Thomas; for Treasurer, Ammi H. Adler and John K. Corrie; for Executive Committee (2), F. E. Anderson, F. J. Kaufman, Richard Moses and K. F. Wince.

Ballot ng is by mail, and the new officers (were to have been) installed at the December 2nd regular meeting.

The meeting was addressed by two speakers on the subject of "The Mechanics and Economics of Centralized Control for Operating Units." Mr. F. H. Trapnell, of E. I. duPont deNemours & Co., Wilmington, Delaware, spoke first, illustrating his points on proper plant layout with slides which showed clearly the advantages to be gained by planning both building and instrumentation around the operation and its special requirements and hazards. The most important factor in proper installation for new construction is, in his opin on, the early consideration of instrumentation problems, which should be taken up at least as soon as the planning of underground pipe lines, company streets and power lines.

Mr. Trapnell also pointed out that in some cases centralized control was not desirable, due to econom c and safety factors involved.

Following Mr. Trapnell's talk, Mr. C. B. Moore, of Moore Products Company, spoke on "The Null Balance Method as Applied to Centralized Control." Also using slides, Mr. Moore explained the operation of the null balance system in instrumentation. He went on to give a brief explanation of the operation of, and the necessity for, throttling, reset and der vative controls. An interesting portion of his talk was devoted to an explanation of "nozzle characteristics" as encountered in measurement and control systems, and of the method of cor-

rection of the natural operating curve for greater linearity.

The meeting scheduled for Monday, December 2, was to have been addressed by Walter P. Wills of the Brown Instrument Company on the subject "Simplified Field Service of Electronic Instruments."

The next meeting of the Charleston Section will be held on Monday, Jan. 6, 1947. The subject is to be "The Selection and Operation of Air Operated Control Instruments," which will be presented by the Foxboro Company, accompanied by a demonstration of the Model 40 instrument.

—ALLYN R. PHILLIPS, *Corr.*

CHICAGO and NORTHERN INDIANA

At a joint meeting of the Chicago and Northern Indiana Sections at Phil Smidt's (Hammond, Ind.) on Tuesday, Nov. 5, approximately 120 members and guests heard Mr. F. Roberson, of the Carnegie-Illinois Steel Corporation, describe "The Latest Developments in the Application of Electronics in Industry."

During the talk Mr. Roberson described a number of late developments in the electronic field, including an electronic "Oil Pool Analyzer," which charts the underground conditions and happenings; "Teleran," a new "Information Please" which gives the pilot of an airplane split-second answers on a television screen; "Eniac," a computing device utilizing some 18,000 electronic tubes; an electronic "Wheel Balancer" and an electronic "Weed Killer."

Other devices such as the electronic spectrometer, micrometer, torque meter, and the trade-named "Totalux," "Liquitrol," and "Televac" were described, all involving the use of electronic tubes.

Mr. Roberson illustrated his talk with a number of slides and pictures, and injected considerable humor into his talk which the audience accepted with enthusiastic response.

Preceding the talk, the meeting was addressed briefly by Mr. Proctor and Mr. Wagner, presidents of the Chicago and the Northern Indiana Sections, respectively, and a Technicolor Sound Motion Picture entitled "Steel, Man's Servant" was presented by Mr. J. H. Cuthbert, also of the Carnegie-Illinois Steel Corporation.

Because of the lengthy discussion following the talk by Mr. Roberson, as well as the slightly longer-than-usual "double-feature" program, the meeting was prolonged well over the usual allotted time.

The December meeting is to be on the subject of "New Developments in Automatic Control Instruments" and the speaker is to be Mr. Albert H. Shafer, manager of the Pittsburgh branch of The Foxboro Company.

The January meeting, scheduled for January 6, 1947, at the Builders' Club, is to take us into the field of nuclear physics. Dr. Truman Kohman, of the Institute for Nuclear Studies, University of Chicago, will talk on "Measurement and Applications of Radioactivity."

—JOHN C. VAALER, *Corr.*

CUMBERLAND

(Received too late for the November issue)

The Cumberland Section held its first fall meeting on Tuesday, October 29, at the Queen City Hotel. The meeting was preceded by a dinner.

The speaker for the technical meeting was Mr. A. A. Hejduk, Manager of Engineering and Sales for the Meriam Instrument Company, Cleveland, Ohio, who gave a very interesting blackboard talk on "Manometer Applications in Industry." Mr. Harold Woolman, Pittsburgh district, Meriam Instrument Co., accompanied Mr. Hejduk here from Pittsburgh.

The next meeting will be held November 26, when the speaker will be Dr. E. D. Haller of the National Technical Laboratories, Bethesda, Md. His topic will be "Hydrogen Ion Measurement."

(Ed. Note—no name signed to this report.)

DETROIT

The October 21st meeting of the Detroit Section was attended by almost 100 members and guests, and featured a talk on "Sound and Vibration Analysis" by Mr. W. R. Saylor of the General Radio Company. The speaker enumerated some of the design problems encountered in sound and vibration measuring equipment caused by such factors as the non-linear response of the human ear to sound, and the difficulty of achieving flat response characteristics in instruments of that type.

Mr. Saylor then proceeded to describe his company's sound-level meter and its companion instrument, the sound analyzer. The latter determines the wavelength and intensity of the noise components picked up by the microphone of the sound-level meter. A large number of slides illustrated the many applications of these instruments, most of them aimed at locating and eliminating objectionable noise. Another attachment to the sound-level meter, the vibration pickup and its control box, permits measurement of vibration on the dial of the sound level meter by using a simple conversion chart and thus eliminates the necessity for separate vibration measuring equipment.

Mr. Saylor also described two other groups of instruments, the vibration meter and its analyzing attachment, and the Strobotac and its companion instrument, the Strobolux. The discussion which followed Mr. Saylor's talk was very instructive. Sound and vibration analysts from all major automotive companies and other industries participated and contributed their own specialized knowledge and experience to round out the overall picture previously drawn by the speaker.

Before and after the lecture, the Foxboro Company displayed their new Dynalog electronic temperature recorder which utilizes highly responsive temperature bulbs that permit a full scale range for as small a temperature differential as two degrees Fahrenheit.

The November 18th meeting was addressed by Mr. Arthur P. Gifford of Consolidated Engineering Corporation, who presented a talk on "The Mass Spectrometer." Commercial Research Laboratories of Detroit sponsored the instrument exhibit before and after the meeting. These exhibits, started as an experiment, have been a real success and will be continued as a regular feature of the meetings of this Section.

The next meeting is to be at 8:00 p. m. on Monday, December 16 at the Ethyl Research Laboratories. The speaker is to be Mr. Henry Kurtz, Scientific Bureau, Bausch & Lomb Optical Company, and his subject will cover "Optics in Instrumentation."

—SIEGMUND KULKA, *Corr.*

KANSAS CITY

The Kansas City Section held its October 29th meeting with Mr. Robert Cooke presiding. Former President Lester Johnson has left the city and Mr. Cooke, formerly Vice-President, has succeeded him. A short business meeting preceded the technical part of the program. A vote to approve the admissions of the Southern Michigan and the South Texas Sections was passed. Mr. Pat Miller was appointed program chairman, following which funds were approved with which to print and mail to all members and local industries the membership of the Kansas City Section.

The speaker of the evening was Mr. A. C. Jensen, chief engineer of Manning, Maxwell & Moore Company, who outlined the metallurgical features of relief valves. A most interesting discussion followed Mr. Jensen's fine paper.

Mr. R. Lewis has been elected to the office of Vice-President, to replace Mr. Cooke. Mr. William Reichow has been appointed Journal correspondent.

The next meeting is scheduled for Tuesday, December 17, 1946, at 7:30 p. m. in Room 306 of the Science Building, 5100 Holmes Ave. The speaker is to be Mr. Harold Vaughn, Engineering Supervisor, Westinghouse Electric Corporation, who will talk on "Carrier Current Relaying." His discussion will deal with the phenomena and applications of telephonic and control functions via high tension power line systems.

—OLIVER S. BOUTROS, *Sec'y.*

NEW JERSEY

November meeting—joint session on November 20 with New York Section at the Men's Faculty Club, Columbia University, New York. Speaker, Mr. V. L. Parsegian, Portable Products Corp. Topic, "A New Galvanometer for Industrial Instrumentation."

December meeting—(received too late for the November issue). The New Jersey Section will meet on Tuesday, December 3, at the Essex House, 1050 Broad St., Newark, at 6:00 p. m. for dinner in the main dining room. The formal meeting will start at 8 o'clock. The speaker will be Mr. Wm. H. Fortney of the Humble Oil & Refining Company, Houston, Texas, who will speak on "Instrument Shop Facility Requirements of a Modern Process Industry."

January meeting—will be held Tuesday, January 7, 1947, at the Essex House. The speaker will be Mr. W. P. Wills of the Brown Instrument Company, and his subject will be "Electric Pyrometry."

—GEO. R. FEELEY, *Corr.*

NEW YORK

The first field trip of the New York Section was held at La Guardia Airport on October 28, 1946. About 45 persons met in the Terrace Room overlooking the landing field for an enjoyable sup-

per. Ten more arrived later to go on the tour.

Mr. Frye and Mr. Geddes of American Airlines conducted the group through the reservations room, the instrument overhaul shop, engine teardown, engine overhaul and propellor shops, ship repair department, and finally into a DC-4 airplane.

The tour lasted about two and one-half hours and was exceedingly interesting, with explanations as we went along, and finally a short question and answer period while comfortably seated in the airliner.

—CHARLES D. COREY, *Corr.*

OAK RIDGE

The regular November meeting of the Oak Ridge Section was held on November 5, 1946, at Grove Hall, with a record attendance of 85. After the dinner and a short business meeting the speaker of the evening, Mr. C. B. Moore of Moore Products Company, Philadelphia, was introduced by the president, Mr. A. V. Novak.

Mr. Moore gave a very interesting and well-received lecture on "The Solution of Instrumentation Problems by the Pneumatic Null-Balance System." He started with the simple null-balance systems which are the basis of his company's products and progressed from temperature and pressure indicators to transmitters and controllers. At each major point in his lecture he brought out the operating characteristics and general applications of the equipment in question. Many informative questions arose and were discussed at the conclusion of the lecture. The new Moore Temperature Transmitter in disassembled form was displayed.

The program committee announced that Mr. P. R. Bell, a well-informed electronics expert of Monsanto Chemical Company, will be the guest speaker at the December meeting. His talk will cover "Counting Circuits." The committee also announced that most of the programs for the year had been arranged. (Ed. note—How about a copy, please?)

—C. W. COVEY, *Corr.*

PHILADELPHIA

(Received too late for the November issue)

The Philadelphia Section held its October meeting on the 16th at the Broadwood Hotel. Approximately 150 members attended. Of this number about 60 attended the pre-meeting dinner.

President Jack Johnston announced at the beginning of the meeting the candidates who had been selected by the nominating committee. Election of officers will be held in November.

Our speaker of the evening was Mr. W. S. Yunker of the Foxboro Company, who delivered an interesting talk entitled "Integrated Process Control Instrumentation for the Pulp and Paper Industry." Slides were used during a portion of his talk to show various processes in the pulp and paper industry. In spite of the fact that the slides were too small for the projector, we were able to gain valuable information from their projection.

Prior to the war the pulp and paper industry was drastically "Under Instrumentized," according to Mr. Yunker. For the past several years, however, this industry has taken tremendous strides toward complete instrumentation with localized panel boards. They have also leaned favorably to packaged instrumentation to offset the maintenance problem presented by dust, moisture, etc.

Mr. Yunker went on to say that comparatively large sums of money have been allotted by pulp and paper mills for process instrumentation. Along with this the instrument personnel of these plants has also been greatly improved. Some of these forward strides will undoubtedly result in a better finished product at a lower cost.

Methods of controlling the flow, pressure and temperature of various types of liquor were discussed, and considerable interest was shown by the audience during the post-talk discussion on this phase of the pulp and paper industry.

The November 20th meeting is to be a panel session at which several engineers representing "user" industries will speak on "Unusual Problems in Instrument Application and Maintenance and How We Solved Them."

The December meeting is scheduled for the 18th in the South Gold Room of the Broadwood Hotel. The speaker will be Mr. Otto Vetter of the Ring Balance Instrument Company of Chicago, and his subject is "The Ring Balance Meter with Some Consideration of Its Application to Elevated Pressures."

The Philadelphia Section I.S.A. held its November meeting at the Broadwood Hotel. Approximately 43 members attended the pre-meeting dinner.

Election for officers was held prior to the meeting by through-the-mail balloting. The following men were selected to head up this section for the next year: John Whiddett, Treas.; Clarence Woods, Sec. The election for President ended in a 50-50 tie necessitating a run-off election. The results will be submitted in our next report.

Dick Rimbach, National Secretary, attended this meeting. He discussed briefly the plans for the 1948 convention.

The main discussion of the evening was varied from the usual one speaker to four local instrument men discussing interesting problems in instrumentation.

The first speaker was Lyman Allen, from the American Viscose Company. He discussed a very unusual and interesting application for the displacement type level controller. The level-controller gave the direct results of maintaining level in a chamber of pre-determined volume, this permitted a measurement of weight with varying gravities due to temperature.

The second speaker was Robert L. Hurley of the duPont Company. Before his talk he asked three men from the group to sit in the front of the room and attempt to solve a problem he was given and had solved. When first sketched on the blackboard the problem was simple. However, each time one of the selected group answered, Mr. Hurley would inject another problem which made the answer incomplete or not correct. The entire build-up was humorous as well as interesting.

The third speaker was Mr. Wm. A. Lindsay of the Atlantic Refining Company. Mr. Lindsay discussed the problem of a cycling air compressor delivering air to four oxidizing units. The compressor would run fully loaded until the receiver pressure built up to 13.8 lbs./in.^{2}, the pressure switch would cause the unloader valves to close and the cycle would repeat itself. The compressor cycle time for this operation was 7 seconds loaded, 2.5 seconds unloaded. This type of operation threw a strain on the gears and motor so it was decided to attempt a method of smoothing out the operation in order to prevent further overheating of the motor.

The logical way of correcting this condition was to partially unload the compressor so it could be adjusted to the required load. A parabolic plug from a control valve was modified to fit into one of the inlet valves in the head end of the compressor and another to fit into one of the inlet valves in the crank end, to balance the work done by the compressor.

Final speaker was Ted Newcomb of the Gulf Oil Company. He discussed a very ingenious method for repairing squirrel cage blowers and for desooting home furnaces. While the topic was not exactly one of instrumentation, it resulted in a good laugh for everyone and also added the necessary touch of spice to complete a perfect evening.

—JOS. H. BERTRAM, *Corr.*

PITTSBURGH

December 19th meeting, "The Relay as an Instrument Auxiliary," by Mr. Charles A. Packard, Struthers-Dunn, Inc., Philadelphia.

January 27th meeting, "Pressure Gages," by Mr. E. A. Levan, United States Gauge Division of American Machine & Metals, Inc., Sellersville, Pa.

—L. F. BOSS, *Corr.*

ST. LOUIS

(Received too late for the November issue)

The St. Louis Section held its regular meeting at the York Hotel in St. Louis on Monday, October 28, 1946. Forty-one members and guests were present for the dinner at 7 p.m. and 20 additional attended the meeting at 8 p.m. Lapel attendance cards were used for the first time, with white cards for members and yellow for non-members.

The meeting was called to order at 8 p.m. by Chairman Munch, who turned the meeting over to Mayer B. Roberts, Program Chairman, who in turn introduced the speakers. The first speaker was Mr. Landon C. Lodge, of the George S. Mepham Company, East St. Louis, Illinois, who spoke on "German Guided Missiles." Mr. Lodge served in the Navy during the late war, and worked on counter-measures against the guided missiles used by the Germans against our ships in the landings on Italian and French coasts. He related that when guided bombs were first used, and before our counter-measures were developed, one-third of all bombs so controlled were hits. These bombs were controlled by radio from the plane which dropped them, and the problem was to transmit a signal to the bombs from the ships that would deflect the missiles from the target by

taking control of the bombs away from the mother planes. British divers obtained a dud bomb, and from a study of this bomb and by other methods, the frequencies used and the methods of control were ascertained. Transmitters were then obtained and successful methods of deflecting the bombs were developed. The speed with which the work was done is shown by the fact that the British had a "jammer" developed three days after the first bombs were dropped by the Germans.

The second speaker was Mr. O. G. Forcade, of Shell Oil Company, Wood River, Ill nois, who spoke on "Maintenance of Pressure Type Thermometers." Mr. Forcade stated that due to the many instruments of this type in the plant—four hundred—it was thought advisable to equip the instrument department for complete maintenance of the Vapor Tension type and the Gas Filled Type of thermometers. Liquid filled and mercury filled thermometers are not completely maintained in the plant.

The filling and calibrating equipment includes (1) an electrically heated, 3-compartment temperature bath, (2) a vacuum pump, and (3) a filling manifold, racks and stands. The first bath contains water, the second oil, and the third melted Lavite. Temperatures up to 900 degrees F. can be obtained. The baths consist of 6-inch pipes, 3½ feet long, with electric heaters around the pipes. Plugged capillaries are blown out with nitrogen under pressure, with the pressure applied alternately to each end. Systems are filled after being fully evacuated by means of the filling manifold. Methods of calibration were explained, as well as methods of determining when the proper amount of filling medium has been introduced.

Lively discussion followed both talks.

The November 25th meeting will be held at the York Hotel, and the speaker will be Mr. C. W. Parsons of the Republic Flow Meters Company. His topic will be "Measurement and Control of Difficult Fluids by Force Balance."

The following meeting is scheduled for December 30, 1946, and it is planned to make this another "Members' Night" program at which the speakers will be members of this Section.

—H. E. ZEFFREN, *Corr.*

SOUTHERN MICHIGAN

The November 13th meeting of the Southern Michigan Section was held at Inmans in Galesburg. After a very fine dinner, attended by 47 members and guests, the meeting was adjourned to the conference room of the Dwight Morrow Plant of Consumers Power Company, Comstock, where a short business meeting was held.

A report of the joint meeting of the Executive, Constitution and By-Laws Committees was read by the Secretary. The report set forth the recommended amendments to the Section By-Laws to bring them into harmony with the National ISA Constitution and By-Laws, and to provide for affiliate membership. A motion was made and passed to adopt the proposed amendments.

Plans were laid for the establishment of an employment committee for the Section. There being no further business the meeting broke up into small groups for a very interesting tour of the plant, where everyone was able to see many different types of .nstruments and control equipment in operation.

The time, place and program of the December meeting will be announced later.

—KEN MEAD, *Corr.*

SOUTH TEXAS

(Ed. note—Although the South Texas Section will not receive its charter until January, its secretary is already on the job furnishing material for the Journal, and for Section News purposes, we are considering this group a member Section right now. RRP)

The South Texas Instrument Society will become the South Texas Section of the Instrument Society of America on January 1st, 1947.

The November meeting was held the night of November 6th in the Central Power & Light Company Auditorium in Corpus Christi. Mr. J. B. McMahon of Republic Flow Meters Company, Chicago, and also Vice-President of the ISA, reported on the ISA Conference and Exhibit held in Pittsburgh during September. Mr. McMahon then gave an illustrated lecture on the force balance principle of measuring pressure, temperature and flow, and recording and/or indicating these measured values at a remote point.

Forty members and two guests present expressed interest in all the proceedings, and especially in Mr. McMahon's talk.

Plans were discussed and tickets distributed for sale to the First Annual Dance of the organization, to be held on December 14th, 1946.

—HOMER C. GIVENS, *Sec'y.*

TENNESSEE

The Tennessee Section of the Instrument Society of America met in joint session with the East Tennessee Section of the Amer.can Institute of Chemical Engineers at the Tennessee Eastman Corporation plant in Kingsport on Thursday evening, November 14. Mr. G. F. Akins of the Eastman Kodak Company, Rochester, N. Y., presented his Automatic Control Demonstration which was given at the recent Instrumentation Conference and Exhibit in Pittsburgh and wh ch proved a remarkable success. The presentation is built around a typical chemical process, and the equipment, devised by himself and his staff, clearly showed the effect of time lag, change of load, etc., upon a controller.

—F. H. THEILE, JR., *Sec'y.*

WASHINGTON

(Received too late for the November Issue)

The 25th meeting of the Washington Section was held at the Pepco Auditorium on Monday, October 21st, at 7:30 p. m. After a short business meeting, the guest speaker, Mr. W. P. Wills, Director of Research for the Brown Instrument Company, gave an illustrated talk on "The Brown ElectroniK Potentiometer."

Mr. Wills' talk included a discussion of the basic des gn of the potentiometer, its accuracy and speed of response.

On October 23d, the members of the Washington Section had the privilege of visiting the U. S. Navy's David Taylor Model Basin, by invitation of Captain Harold E. Saunders, Director, and Dr. D. F. Windenburg. The guided tour, which was a prev ew of the Navy Day showing, was very interesting. We were shown most of the facilities and methods of the various departments for determining in advance the reaction of the various seagoing vessels to normal and induced hazards.

—G. M. ROLLS, *Corr.*

WAYNE COUNTY

The October 28th meeting of the Wayne County Section was well attended. Mr. Herb Barnum, ISA Vice-Pres dent and Delegate from the Detroit Section, Mr. James Gambrill, President of the Detroit Section, and Mr. Wm. Baker, Delegate from the Wayne County Section, led a panel discussion on "Process Control Terminology." Blackboard illustrations were discussed and comments solicited from the floor. Folders defining the terms used (furnished by the Minneapol s-Honeywell Regulator Co.) were distributed. Mr. Baker also distributed a very useful set of mimeographed sheets on temperature and pressure corrections for flowmeters.

A door prize provided by Mr. Baker was won by Mr. Muenchausen of the Detroit Edison Company.

Mr. C. F. Goldcamp, of Instruments Publishing Company, and Chairman of the National Employment Registration Comm ttee, was also present, and spoke for a few minutes on the activities of his committee.

Mr. Baker has been appointed Journal Correspondent for this Section and will henceforth provide the material requested for the Journal.

—JOHN MACPHERSON, *Pres.*

Constitution of The Instrument Society of America

(Amended Sept. 15, 1946)

ARTICLE I

Name

(1) The name of this Society is THE INSTRUMENT SOCIETY OF AMERICA.

(2) Authorized local groups shall be known as SECTIONS.

ARTICLE II

Objectives

(1) The objectives of the Society shall be to advance the arts and sciences connected with the theory, design, manufacture and use of instruments in the various sciences and technologies.

ARTICLE III

Membership

(1) The membership of the Society shall consist of:

Honorary Members
Members
Associate Members
Student Members

ARTICLE IV

Qualifications for Membership

(1) Any person interested in the objectives of the Society shall be eligible for election to membership.

(2) Admission to the Society in any grade of membership except Honorary shall be by action of the Section.

(3) Transferral between Sections requires the approval of the Section to which transfer is requested.

ARTICLE V

Dues

(1) The amount and method of collection of dues of the Society shall be as provided in the By-Laws.

(2) At least 50% of all monies collected by the Society as dues of individual members shall be remitted to the members' Section no later than three calendar months after date of receipt.

(3) No assessments upon Sections as such shall be made.

(4) Assessments upon Members and Associate Members shall be made only by ⅔ majority of the votes cast by the Board of Directors.

ARTICLE VI

Government

(1) The control and management of the affairs, property and funds of the Society shall be vested in the Board of Directors.

(2) The control and management of the affairs, property and funds of the Sections remain in the Sections individually.

(3) All questions coming before the Society, its governing bodies and committees shall be decided by a majority of the votes cast except as otherwise provided by the Constitution and By-Laws.

(4) All members, other than Student Members, shall be entitled to one vote on all questions coming before the Society.

(5) Robert's Rules of Order, Revised, where applicable, shall determine the conduct of business in all meetings of the Society, its governing bodies and committees except when inconsistent with the Constitution and By-Laws.

ARTICLE VII

Officers and the Executive Committee

(1) Officers: The officers of the Society and their terms of office shall be:

President	One Year
First Vice President	Two Years
Vice President	Two Years
Vice President	Two Years
Vice President	Two Years
Treasurer	Two Years
Executive Secretary	Two Years

Two of the Vice Presidents shall be elected initially for a term of one year, and thereafter for a term of two years.

(2) Executive Committee: The Executive Committee shall consist of the officers, the latest living ex-president and such additional members as shall be elected by the Board of Directors.

ARTICLE VIII

Election of Officers

(1) The officers, as previously provided, shall be elected by the Board of Directors.

(2) This election shall be held at the Annual Meeting of the Society.

(3) All members except Associate Members and Student Members shall be eligible for election to any office.

(4) No regularly elected officer, except the Executive Secretary, shall succeed himself in the same office.

(5) Any office becoming vacant shall be filled by appointment by the Executive Committee until the next meeting of the Board of Directors.

ARTICLE IX

Board of Directors

(1) Each section shall elect one member to the Board of Directors.

(2) The officers of the Society shall be ex-officio members of the Board of Directors.

(3) Each member of the Board of Directors, except members ex-officio only, shall have a voting power equal to the number of voting members in the Section he represents.

(4) The term of office of the members of the Board of Directors, except members ex-officio only, shall be two years.

(5) A quorum of the Board of Directors shall consist of a majority of its voting members, who must also represent a majority of the voting members of the Society.

ARTICLE X

Amendment of the Constitution

(1) Amendment of the Constitution may be proposed by a petition signed by one hundred or more voting members of the Society or by resolution adopted by the Board of Directors. The proposed amendment, with a statement of the reasons therefor, shall be mailed by the Executive Secretary to all voting members within 30 days. Voting shall be by letter ballot. Adoption of the amendment shall be decided by a majority of the votes cast. The Executive Secretary shall deliver the ballots received to the Executive Committee, not sooner than 30 days nor later than 60 days after the mailing of the last ballot.

(2) The Board of Directors shall amend the By-Laws so that they are in harmony with any amendment to the Constitution.

By-Laws of The Instrument Society of America

(Amended Sept. 15, 1946)

ARTICLE I

Grades of Membership

(1) The grade of Honorary Member shall be reserved for those individuals whose outstanding contributions to the advancement of the arts of instrumentation are worthy of special recognition. The recommendation that an individual be made an Honorary Member may be made by any Member of the Society. It must be made in writing, including a description of the work performed, endorsed by ten other Members and presented to the Secretary of the Society who will submit it to the Board of Directors at their next meeting. The individual will be made an Honorary Member if the recommendation receives a favorable vote of the majority of the Board and the Secretary of the Society shall then so notify him.

(2) Any person interested in the objectives of the Society shall be eligible for election to the grade of Member.

(3) The grade of Associate Member shall be limited to those whose principal interest and occupation are not in the instrument field.

This limitation may be waived by a Section. Permission to waive this limitation may be rescinded by the Board of Directors at any time after January 1, 1948.

(4) A person is eligible to become a Student Member if:

(a) He is registered as a full-time student, or

(b) He is enrolled in an organized instrument apprentice course. Apprentices are eligible only during the first two years of their course.

ARTICLE II

Membership Election Procedure

(1) The "Application for Membership" form shall be subject to approval by the Board of Directors.

(2) Application for membership in the Society shall be made by filling out the "Application for Membership" form and submitting it, properly endorsed and with the correct dues, to the Section with which the applicant wishes to become affiliated. Proper authorities of the Section shall review the application with respect to the applicant's acceptability and grade of membership. Approval of the applicant by the Section shall constitute election to membership and shall be so indicated on the application form. This form with the correct dues attached, shall be forwarded to the Executive Secretary of the Society who shall notify the member of his election.

ARTICLE III

Transfer of Affiliation

(1) Transfer of affiliation from one Section to another shall be made with the approval of the Section to which the member is to be transferred. Affiliation with the original Section shall continue until the transfer is effected.

ARTICLE IV

Additional Affiliation

(1) Any member may affiliate with additional Sections, subject to the regulations of such Sections. Such additional affiliations shall carry no voting power in matters coming before the Society.

ARTICLE V

Termination of Membership

(1) A member may resign from the Society at any time by signifying his intention in writing to the Executive Secretary who shall then notify the secretary of the Section with which the member was affiliated.

(2) Any member whose dues are unpaid three months after the date due shall be considered inactive and the Executive Secretary shall so notify him and the secretary of the Section with which he is affiliated. An inactive member shall have no vote in any matters pertaining to the Society and shall receive no notices or publications from the National Office. An inactive member shall be restored to active status immediately upon the payment of his dues.

(3) Any member whose dues are unpaid one year after the date due shall have his name stricken from the membership roll of the Society and the executive Secretary shall so notify him and the secretary of the Section with which he is affiliated.

(4) The application for reinstatement of any member whose name has been stricken from the membership roll for non-payment of dues shall be considered in the same manner as the application of a new member.

(5) The Board of Directors may excuse a member from payment of dues if, in their judgment, there is good and sufficient cause.

(6) The Board of Directors may suspend for a definite or indefinite period, or expel a member for cause. This shall not be done until the member has been given ample opportunity to defend his

actions. A suspended member shall have inactive status until reinstated by the Board. The name of an expelled member shall be stricken from the membership roll and he shall not be considered eligible for re-election to membership. Pro-rated dues shall be refunded to an expelled member for the length of his unexpired term.

ARTICLE VI
Dues

(1) The annual dues shall be as follows:

Honorary Member	None
Member	$10.00
Associate Member	5.00
Student Member	2.00

(2) Dues shall become due and payable on each anniversary of the member's election to membership. A bill for such dues shall be mailed to the member by the Executive Secretary at least ten days before the member's anniversary.

(3) Dues shall be paid to the Executive Secretary of the Society but each Section may use whatever means it may select to facilitate and expedite the collection of these dues from its affiliated members. Dues collected by the Sections shall be transmitted immediately in full to the Executive Secretary.

(4) The Executive Secretary shall forward a membership card to each member as a receipt for dues received and shall remit to the Section within three months, fifty per cent of all such dues.

ARTICLE VII
Duties of Officers

(1) The President shall be the executive head of the Society. He shall preside at all annual and special meetings of the Society and at all meetings of the Board of Directors.

(2) The First Vice President shall perform the duties of the President in case of the absence of the President or the inability of the President to act.

(3) The Executive Secretary shall act as recording and corresponding secretary of the Society. He shall keep or cause to be kept full and complete record of the membership of the Society. He shall act as Secretary at all meetings of the Board of Directors and of the Society and shall perform such other duties as shall be delegated to him by the Board of Directors. The office of the Secretary shall be at the principal office of the Society.

(4) The Executive Secretary shall receive a salary which shall be fixed by the Board of Directors. No other Officer of the Society shall, as such, receive any salary or compensation for his services.

(5) The Treasurer shall be the financial officer of the Society. He shall keep or cause to be kept complete records of all moneys received and disbursed by or on behalf of the Society and shall secure proper receipts for all moneys disbursed. He shall report to the Board, whenever requested, the financial condition of the Society. He shall be an ex-officio member of the Finance Committee and shall perform such other duties as shall be delegated to him by the Board of Directors.

(6) The Executive Secretary and the Treasurer shall each give a bond in a penal sum and with a surety or sureties approved by the Board of Directors, for the faithful performance of their duties. If a surety company bond is furnished the premium therefor shall be paid by the Society.

(7) The President, Secretary and Treasurer shall submit written annual reports at all annual meetings of the Society. The report of the President shall be made on behalf of himself as President and on behalf of the Board of Directors. The report of the Treasurer shall be certified by a competent public accountant.

(8) All instruments for the payment of money by the Society shall be drawn in the name of the Society, signed by the Secretary or Treasurer and countersigned by the Treasurer or Secretary or by a member of the Finance Committee. The signing and countersigning shall in no event be done by the same person.

ARTICLE VIII
Committees

(1) Executive Committee

The Executive Committee shall carry out the policies determined by the Board of Directors.

(2) The following committees shall be appointed by the President with the approval and consent of the Board of Directors.

(a) Advisory Council
(b) Instrument Manufacturers' Advisory Committee
(c) Constitution Committee
(d) Co-ordinating Committee
(e) Education Committee
(f) Employment Committee
(g) Finance Committee
(h) Meetings Committee
(i) Membership Committee
(j) Nominating Committee
(k) Publications Committee
(l) Recommended Standards Committee
(m) Research Committee
(n) Sections Committee

(3) The duties of these committees shall be defined by the Board of Directors.

(4) The Chairman of each of these committees shall be appointed by the President, for a period of two years.

ARTICLE IX
Meetings

(1) Meetings of the Society may be held at such times and places as the Board of Directors may direct, except as provided for in the Constitution.

(2) The Annual Meeting of the Society shall be held in September.

(3) Announcements of all meetings of the Society shall be published and the Secretary shall also mail a notice of same to each member of all grades, not less than thirty (30) days before the date of each meeting.

ARTICLE X
Chartering of Sections

(1) Any group of individuals interested in the objectives of the Society may petition the Executive Committee for a Section charter.

(2) Upon approval of the petition by the Executive Committee, the Executive Secretary shall issue the charter in an approved form.

(3) The charter fee shall be ten dollars and shall accompany the petition.

ISA
Employment Service

In printing these announcements the Society assumes no obligation as to responsibility of employers. Those replying to announcements should include two copies of their reply. When testimonial documents are to be included, copies of such documents and *not* the originals should be sent. The Society regards acknowledgment by employers of all applications as an act of courtesy but can assume no responsibility for their failure to do so. Address all replies to Employment Registration Committee, Instrument Society of America, 1117 Wolfendale St., Pittsburgh 12, Pa.

—C. F. GOLDCAMP, *Chmn. Employ. Reg. Com.*

SITUATIONS OPEN

ELECTRONICS ENGINEER or Radio Engineer for research on unconventional applications of audio frequency circuits and design of portable instruments for blind guidance. Box 8.

. . .

TECHNICALLY TRAINED MAN to operate an X-ray diffraction unit and to supervise electron microscope studies with particular interest in the structure of manganese dioxide and similar semiconductors. Box 9.

. . .

GRADUATE ENGINEERS for work in an engineering squad on instrumentation and process controls in the chemical industry. Box 10.

. . .

INSTRUMENT TECHNICIAN qualified in maintenance of control equipment such as air-operated controllers and electric control devices, also precision instrument adjustments and trouble shooting. Box 11.

. . .

INSTRUMENT MAN for maintenance and repair of electrical and temperature indicators, recorders, etc. Also for development work in the experimental and test development laboratory of refrigeration industry. Box 12.

. . .

INSTRUMENT MECHANIC experienced on pneumatic controllers of all types for air conditioning industry. Box 13.

. . .

INSTRUMENT MEN with one or more years experience in maintenance of process instrumentation. Should have type of experience and personality which will permit development into supervisory positions. Box 14.

. . .

GLASS BLOWER thoroughly familiar with thermometer tube making for position with manufacturer of control instruments. Box 15.

. . .

INSTRUMENT MEN for construction and production, service and repair for positions with industrial instrument manufacturer. Box 16.

. . .

INSTRUMENT TECHNICIAN experienced in maintenance and calibration of all types of instruments. B. S. degree preferred to assure future advancement. Box 17.

. . .

CONSULTING ENGINEER for design engineering to arrive at a satisfactory unit such as will permit merchandising in a competitive market within a specific price range of a new type of liquid level gage for use with oil tanks. Box 18.

. . .

INSTRUMENT SALESMAN by manufacturer of process control instruments. Must be graduate engineer and have previous sales experience. Should be thoroughly familiar with instrument application. Location, northern Ohio. Box 19.

. . .

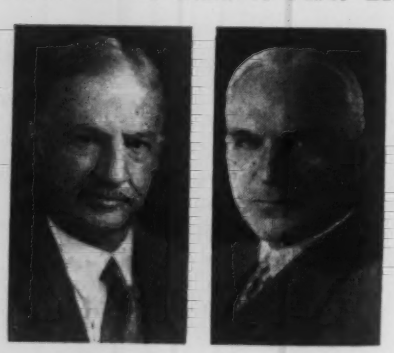
MECHANICAL OR ELECTRICAL ENGINEER for development work on instruments in research organization. Recent graduate preferred. Box 20.

Technical Society News

ASME HONORS TWO FAMOUS INSTRUMENT MEN

NEW YORK CITY.—At the banquet of the American Society of Mechanical Engineers, feature of its Annual Meeting held here December 2 to 6, its highest medals were awarded to two engineers who have distinguished themselves in measurement and automatic-control technology:

MORRIS EVANS LEEDS, chairman of the board of Leeds and Northrup Co., and president of the Board of Public Edu-



Leeds Gibson

cation, of Philadelphia, received the highest honor, the ASME Medal, which is awarded annually for distinguished service in engineering and science, specifically for "outstanding achievements in the invention and development of electrical and temperature measuring instruments, and in the field of industrial relations."

Dr. Leeds pioneered in the development of instruments based on the null method of electrical measurement, and his patent on the Leeds mechanical-relay electrical recorder covers the method which is today the basis of most refined, instrument-actuated process control. For this work he was honored by Franklin Institute.

In the field of industrial relations he organized and maintained an industrial system of employment stabilization in his own firm, and worked in many ways for the promotion of national economic planning, social security and better industrial relations.

He was born in Philadelphia in 1869. In 1888 he was graduated from Haverford College which conferred on him the honorary degree of doctor of laws last June. For many years he has served on its board of managers. Franklin Institute gave him the Longstreth Medal of Merit in 1920. In 1945 he received the first Rotary Award from the Philadelphia Rotary Club.

NORMAN ROTHWELL GIBSON, vice president and director of the Buffalo Niagara Electric Corp., Buffalo, N. Y., received the Holley Medal, given for "some great and unique act of genius of an engineering nature," specifically "for his achievements and inventions which have advanced the science of hydraulics and hydromechanics, including an original method of water measurement which made possible more accurate testing of large hydroelectric generating units."

Mr. Gibson was born in Guelph, Ontario, in 1880, and was educated at the University of Toronto, where he received the honorary degree of doctor of engineering in 1931. Franklin Institute of Philadelphia awarded him the Elliott Cresson gold medal in 1930, for his invention of the Gibson method and apparatus for measuring flow of liquids in closed conduits.

—E. HARTFORD, *Exec. Ass't Sec'y*

Secretaries and Publicity Committee Chairmen

"Closing date for each issue of *Instruments* is the 25th of the preceding month."

This is the general rule, applicable to reports of past events.

To this rule there is an exception: BRIEF announcements of next meetings may be wired in later—up to the 3rd or 4th day of the month of issue.

Bear in mind that *Instruments* is mailed on the 15th of each month. If a meeting is to be held on May 14, 15, or 16, no use announcing it in the May issue: it should be announced in the April issue. —MFB

ASME ANNUAL MEETING

At the Sixty-seventh Annual Meeting of the American Society of Mechanical Engineers, held Dec. 2-6 in New York City, more than two hundred technical papers were presented, including many on measurement and control subjects. As this issue of *Instruments* goes to press, the list of available preprints and reprints is not complete, but the prices for papers ordered by mail range from 15 to 30 cents a copy, therefore *Instruments* readers should send a minimum of 15 cents per copy. (If the remittance is insufficient, bill will be rendered for the difference.) Address orders directly to ASME Publication Sales, 29 W. 39th St., New York 18, N. Y. (DO NOT order through *Instruments*.)

A partial list of instrumentation papers follows:

"Surface Roughness, Waviness, and Lay and Its Application in Actual Practice," by R. Shell.

"Instrumentation for Helicopters," by C. F. Savage and R. G. Jewell.

"Instrumentation for Jet-Propelled Planes," by C. A. Edman.

"Further Remarks on the Analogy Between Heat and Momentum Transfer," by R. C. Martinelli.

"Instrumentation for Flight-Testing of Thermal Anti-icing Systems," by W. C. Droege.

"Determination of the Thermal Correction for a Single Shielded Thermocouple," by W. M. Rohsenow.

"Electrically-heated Glove for Determining Local Values of Heat-transfer Coefficients," by J. K. Goss.

"Furnace Temperature Control of Large Steam-Generating Units," by Otto de Lorenzi.

"Measurement of Flow at Supersonic Velocities," by Neil P. Bailey.

"Analysis of Viscosity Data From Norman Flowmeter Tests," by L. K. Spink.

"Orifice Discharge Coefficient for Liquids in Viscous Flow Range," by G. S. Peterson.

"Testing Naval Pilotless Aircraft," by Commander Grayson Merrill.

"The Use of Electric Gaging Equipment in Machine Design," by P. E. Nokes and E. G. Carr.

"Measurement of the Viscosity and Shear Elasticities of Liquids by Means of a Torsional Vibrating Crystal," by W. P. Mason.

AKRON INSTRUMENT SOCIETY

The November meeting of the Akron Instrument Society was held at the Guggenheim Aeronautical Institute on Tuesday, November 26th.

During the business meeting, Mr. Earl E. Larsen announced that the Papers Committee had decided to undertake the compilation of a handbook on Instrumentation, the data at present being too widely scattered. The Society endorsed the idea and several members are already working on various sections. We anticipate great results from this program.

Following the business meeting, President C. B. Luther introduced Mr. Arthur Herman, of the Taylor Instrument Cos., whose subject was "Air Operated Controls." Mr. Herman traced the development of pneumatic controls from the simple nozzle and flapper to the modern instrument with proportional response, automatic reset and preact or derivative action, explaining what part each unit played in the completely stabilized controller of today. Mr. Herman showed the application of Taylor controls to various industrial problems, including those requiring ratio control, time schedule control and controllers reset by hand or automatically from a distance.

After Mr. Herman's very interesting discussion, the 63 members and guests present were conducted on a tour of the Institute by Dr. Paul O. Huss, Director of Meteorology. We were shown the large vertical wind tunnel where airship and plane models are tested, the basin for hydraulic tests, the whirling arm where models and wing sections can be tested up to 200 miles per hour, and all of the equipment that goes to make up this research laboratory, including one of the finest libraries on aeronautics in the country.

President Luther announced that our next meeting would be on Dec. 17th, the speaker to be Dr. Haller of the National Technical Laboratories of Pasadena, Cal., whose subject will be pH measurement. Announcement of the meeting will appear in the Engineering Societies column in the Akron Beacon Journal.

—FRED APPEL, JR., *Secretary.*

ATLANTA

The new Executive Committee of the Georgia Society for Measurement & Control consists of David W. Choate, Brown Instrument Co., *President;* M. C. Walker, Television Electronics Co., *Vice President;* Edwin R. Foss, Powers Regulator Co., *Treasurer;* John B. Roberts, Atlantic Steel Co., *Secretary;* Kenneth P. Knudsen, Jr., Wheelco Instruments Co., *Past President;* M. Virgil Davis, Atlantic Steel Co. and Milton F. Meri, Republic Flowmeters Co., *members.* —JOHN B. ROBERTS, *Sec'y.*

HARTFORD SOCIETY FOR MEASUREMENT AND CONTROL

The next meeting of the Hartford Society for Measurement and Control will be held at the City Club in Hartford on Wednesday, December 18th. There will be a dinner at 6:30 P.M. with the technical program taking place at 8:00 P.M.

Speaker for the evening will be Mr. F. G. Tatnall of the Baldwin Locomotive Works, Locomotive and Southwark Div., Philadelphia, whose talk will be entitled, "Strain Gages and Their Use in Industry."

INDIANAPOLIS TECHNICAL INSTRUMENT SOCIETY

The regular meeting of the Indianapolis Technical Instrument Society was held November 5, and was very well attended. Mr. H. P. Rockwell, a member of our group, gave a very informative talk on "Instrumentation in Photography." Mr. Rockwell gave a very good résumé of the types of instruments available—light intensity, light values, density, shutter speeds, etc., with the advantages and limitations of each. A very lively discussion period followed the talk.

The December meeting will include the election of officers for the coming year and a vote will be taken as to whether or not our group will join the I.S.A. Also, Mr. Roy Thurman, of the Indianapolis Power and Light Co., will give a short talk on "Heat Pump."—MORRIS UNDERWOOD, *Sec'y-Treas.*

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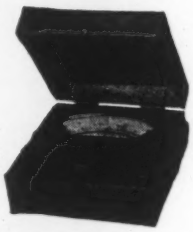

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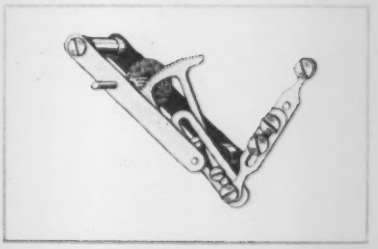
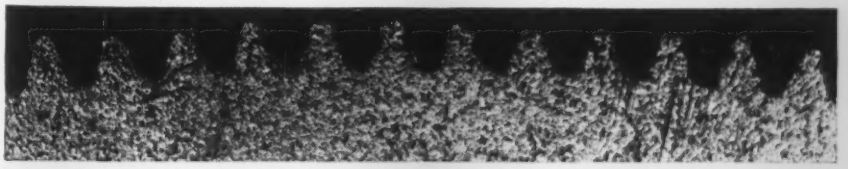
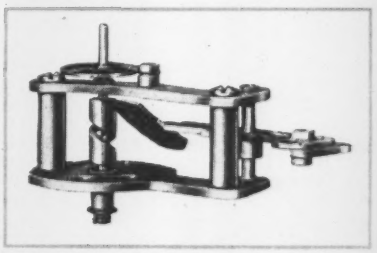
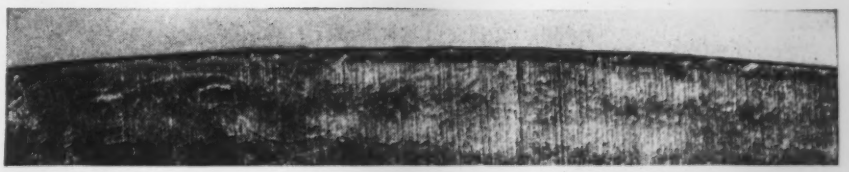




2 Magnified 12 times, the teeth of this new, unused sector are jagged – anything but uniform. Pinion teeth are cut the same way. Friction, wear and consequent inaccuracies are caused by these rough surfaces rubbing together.



3 Helicoid Gage movement has a polished, graphited Bakelite cam and a polished helicoid roller – instead of sector and pinion.



4 Cam of Helicoid movement magnified 12 times, shows smooth, polished surface. Helicoid roller surface is also highly polished. Longer wear and smoother operation result from these two polished surfaces in rolling, point contact.

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TRADE MARK

Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on page 785.

N-501 **Controls and Resistors.** 16-page 8½" × 11" Catalog No. 46A illustrates and describes the following items: Attenuators, fixed resistors, slider resistors, power resistors, ballast resistors, glasohm resistors, greenohn resistors, voltage regulators, metal tube resistors, impedance controls, wire wound controls, composition controls, and power resistor controls. Clarostat Mfg. Co., 130 Clinton St., Brooklyn 1, N. Y.

N-502 **Silicone Fluids for Use in High-vacuum Diffusion Pumps.** 8-page 8½" × 11" Notebook No. 2 describes two new silicone fluids as able to produce vacua ranging up to 5 × 10^{-8}, and yet withstand exposure to air and moisture at operating temperatures without appreciable decomposition. Dow Corning Corp., Midland, Mich.

N-503 **Metal Bellows.** 32-page 8½" × 11" Bulletin No. 1300 illustrates and describes a representative list of sylphon bellows. Essential data are presented and the field of application is indicated. A number of typical assemblies are shown. The Fulton Sylphon Co., Knoxville 4, Tennessee.

N-504 **Armored Rotameters.** 8-page 8½" × 11" Catalog Section 40-A illustrates and describes completely-armored variable-area flow-rate meters. Designed specifically for use where high pressure, high temperatures, possibility of liquid hammer or handling of hazardous gases or liquids makes the use of rotameters with exposed glass tubes dangerous or impractical. Fischer & Porter Co., Dept. 5C-7, Hatboro, Pa.

N-505 **Testing Instrument Lubricants.** 12-page 8½" × 11" reprint of an article entitled "The Comprehensive Laboratory Testing of Instrument Lubricants," by G. E. Barker, G. E. Alter, Jr., C. E. McKnight, J. R. McKlveen and D. M. Hood from the *ASTM Bulletin*, March 1946. Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh 13, Pa.

N-506 **Temperature Controllers.** 6-page 8½" × 11" folder pictures and describes maker's line of temperature controllers "for every purpose." Burling Instrument Co., Newark 3, N. J.

N-507 **Liquid Level Gages.** 2-page 8½" × 11" Data Sheet No. 70 pictures and describes Model 70 tank liquid level gages for use with tanks from 3 to 60 ft. high. Includes installation diagrams. Trimount Instrument Co., 37 W. Van Buren St., Chicago 5, Ill.

N-508 **Diesel Engine Pyrometers** 2-page 8½" × 11" Bulletin P1233 pictures and describes "Commercial-type Diesel Engine Pyrometer," manufactured to meet the specifications set up by large manufacturers of diesel engines. The Bristol Co., Waterbury 91, Conn.

N-509 **"General Radio Experimenter."** 8-page 6" × 9" Vol. 21 No. 1 of this house organ features an article by Arnold Peterson entitled "Output Systems of Signal Generators." General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

N-510 **Resistor Data.** 8-page 8½" × 11" folder opens to a wall chart of engineering data on maker's "Akra-Ohm Precision Resistors," in fixed wire-wound types. Shallcross Mfg. Co., Collingdale, Pa.

N-511 **Special-built Time Switches.** 4-page 8½" × 11" Bulletin T-55 describes maker's ability to make special time switches for volume users. Examples are shown. Automatic Temperature Control Co., Inc., 34 E. Logan St., Philadelphia 44, Pa.

N-512 **Midget Metal Base Relays.** 4-page 8½" × 11" Bulletin 104 pictures and describes line of midget metal base relays for standard and for heavy duty in a variety of single- and double-pole contact arrangements. Includes dimensional drawings. Ward Leonard Electric Co., 31 South St., Mt. Vernon, N. Y.

N-513 **Electronic Micrometer.** 4-page 8½" × 11" bulletin pictures and describes the Carson Electronic Micrometer in two models: "Model L" which measures dimensions of conducting parts without pressure, and "Model M" which measures the thickness of any material—hard or soft, conducting or non-conducting. Carson Micrometer Corp., 28 Edison Place, Newark 2, N. J.

N-514 **"Weston Engineering Notes."** 8-page 8½" × 11" Vol. 1, No. 3 of this house organ features an article on the cadmium standard cell giving the history, construction details and uses of this electrical standard. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

N-515 **Portable Pyrometers.** 4-page 8½" × 11" Bulletin D602-4 pictures and describes maker's line of portable pyrometers. Specifications for proper selection of extension holders, tips, etc., are included in chart form. Weelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill.

N-516 **Capacitors.** 40-page 8½" × 11" catalog pictures and describes the Tobe line of capacitors and "Filterettes." Tobe Deutschmann Corp., Canton, Mass.

N-517 **Oxygen Indicator.** 4-page 8½" × 11" Bulletin No. DW-3 pictures and describes the "M.S.A. Type C Oxygen Indicator" for measuring the oxygen content of gaseous mixtures. Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh 8, Pa.

N-518 **Continuously-adjustable Transformers.** 8-page 8½" × 11" Bulletin Form 424-F pictures and describes the new line of "Variac" continuously-variable transformers. Includes table for easy selection and circuit diagrams of the various types. General Radio Co., Cambridge 39, Mass.

N-519 **Shielded Locking Connector.** 2-page 8½" × 11" Catalog Sheet Sec. B pictures and describes "Na-Ald" weatherproof, vibration-proof locking plugs, connectors and associate sockets. Alden Products Co., 117 N. Main St., Brockton 64, Mass.

N-520 **Micrometers.** 8-page 8½" × 11" bulletin pictures and describes the "Scherr" line of micrometers calibrated to read down to 0.0001". George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y.

N-521 **Controlled Volume Chemical Pumps.** 4-page 8½" × 11" Bulletin No. 468 pictures and describes this maker's controlled volume chemical pumps and automatic chemical feed systems, including automatic proportioning and ratio control systems, automatic pH control, and automatic control by temperature, pressure, conductivity or liquid level. Milton Roy Co., 1300 Mermaid Ave., Philadelphia 18, Pa.

N-522 **Process Controllers.** 8-page 8½" × 11" Bulletin 17 pictures and describes process controllers, control components, measuring components and instrument combinations. Includes application data for the various components. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

N-523 **Insulation Tester.** 4-page 8½" × 11" Circular R-25-A pictures and describes "Model 799" insulation tester,

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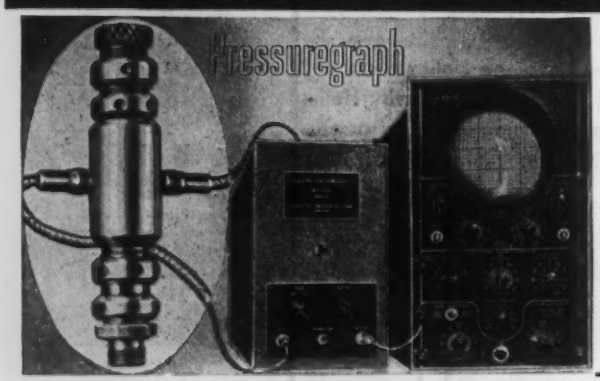

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10,000 megohms, for leakage resistance measurements at low potentials. Weston Electrical Instrument Corp., Newark 5, N. J.

N-524 **Electrical Indicating Instruments.** 12-page 8½" × 11" Bulletin No. GEA-3432B pictures and describes the G-E concentric-scale a-c. and d-c. instruments. Line includes ammeters, voltmeters, wattmeters, varmeters, frequency meters, etc. General Electric Company, Schenectady, N. Y.

N-525 **Glass Tubing Cutter.** 4-page 4" × 9" folder pictures and describes the Eberbach Glass Tubing Cutter, a machine to be employed where glass tubing or rod, and porcelain or silica tubing are cut frequently. Eberbach & Son Co., Ann Arbor, Mich.

N-526 **Instruments for Electroplating.** 16-page 8½" × 11" Bulletin 98166 covers the application of automatic control instruments to electroplating and cleaning operations. Includes tables of process temperature control recommendations and diagrammatic sketches of instrument hookups. Taylor Instrument Companies, Rochester, N. Y.

N-527 **Recording, Indicating, Controlling Instruments.** 4-page 8½" × 11" Bulletin 359 pictures and briefly describes the various types of instruments available from this manufacturer for industrial applications. Builders-Providence, Inc., Providence 1, R. I.

N-528 **"Aerovox Research Worker."** 4-page 8½" × 11" Vol. 18 No. 6 of this house organ features Part 4—Cavity Resonators, of the V.H.F. Primer. Aerovox Corp., New Bedford, Mass.

N-529 **Hot Transformer Alarm.** 4-page 8½" × 11" Bulletin No. 870 pictures and describes the "Tesco Therm-alarm," a 3-oz. device that shows visually when a transformer has been operated too hot. The Eastern Specialty Co., Philadelphia 40, Pa.

N-530 **Liquid Level Gages.** 32-page 8½" × 11" Catalog No. 31 pictures and describes the "Triumph" line of magnetic direct-reading liquid level gages in gear-driven types, tube types and side arm types. The Boston Auto Gage Co., Pittsfield, Mass.

N-531 **Pressure Gages.** 4-page 8½" × 11" bulletin pictures and describes this maker's pressure gages and pressure recording instruments for pressure, vacuum and compound uses. Gotham Instrument Co., Inc., 139 Wooster St., New York 12, N. Y.

N-532 **Electron Tubes.** 14-page 8½" × 11" catalog pictures and describes this maker's line of electron tubes including thyratrons, and rectifiers of several types. Chatham Electronics, 475 Washington St., Newark 2, N. J.

N-533 **Binocular Magnifier.** 4-page 3½" × 6¼" folder pictures and describes the "Super Sight Headloupe Model 502" for magnification of fine work with depth perception. The Boyer-Campbell Co., 6540 St. Antoine St., Detroit 2, Mich.

N-534 **Recording Materials.** 44-page 6" × 9" booklet describes maker's line of photographic recording materials for use with cathode-ray oscillographs, galvanometer oscillographs and similar instruments. Includes information on physical and photographic properties of films and papers, and other useful information. Industrial Photographic Sales Division, Eastman Kodak Co., 343 State St., Rochester 4, N. Y.

N-535 **Laboratory and Maintenance Instruments.** 12-page 8½" × 11" bulletin pictures and describes "Model 179-A" Beat Frequency Oscillator, "Model 210-A" Signal Generator, "Model 217-H" Transmission Measuring Set, "Model 280-A" Beat Frequency Oscillator, and "Model 330-A" Capacity-Resistance Bridge. The Clough Brengle Co., 6014 Broadway, Chicago, Ill.

N-536 **Moisture Determinations.** 4-page 8½" × 11" Bulletin pictures and de-

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for precision linear measurements up to 4" reading to .00005"

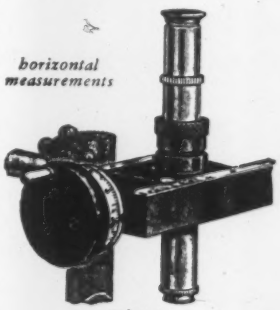

Fig. 1

Dependability and precision are insured by extremely accurate screws and fine craftsmanship.

When used with the various types of support bases available they can be used as small comparators for horizontal linear measurements (Fig. 1).

The microscope mounted parallel to the slide permits depth measurements and micrometer focusing (Fig. 2).

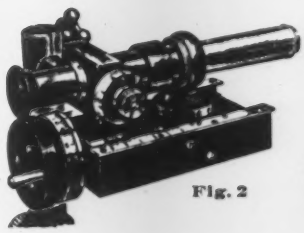

Fig. 2

Vertical orientation permits use as a small cathetometer for vertical linear measurements (Fig. 3). Interchangeability of microscope objectives and eyepieces permits a wide selection of magnifications.

These instruments are ideal for the variety of applications required in testing and inspection departments, laboratories and shops.

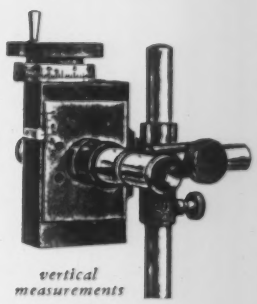

Fig. 3

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scribes the "Aquatrator," an instrument for making moisture determinations by the Karl Fischer method. Precision Scientific Co., 1736 N. Springfield Ave., Chicago 47, Ill.

N-537 **Gage Blocks.** 2-page 8½" × 11" bulletin pictures and briefly describes maker's line of heavy-duty gage blocks. Webber Gage Co., 12901 Triskett Rd., Cleveland 11, Ohio.

N-538 **Electrical Indicating Instruments.** 4-page 8½" × 11" bulletin pictures and describes line of electrical indicating instruments including microammeters, ammeters, thermal milliammeters, thermal ammeters, milliammeters, voltmeters, and volt-ohm-milliammeters, Meters, Inc., 915 Riveria Dr., Indianapolis 5, Ind.

N-539 **Automatic Regulators for Combustion Control.** 12-page 8½" × 11" catalog pictures and describes a line of regulators for use with stokers, pulverized fuel, gas and oil burners. Ace Instrument Co., Inc., 123 W. 21st St., New York 11, N. Y.

N-540 **"Weston Engineering Notes."** 8-page 8½" × 11" Vol. 1 No. 4 of this house organ features an article describing a complete direct-reading Gm tube tester. Weston Electrical Instrument Co., 614 Frelinghuysen Ave., Newark 5, N. J.

N-541 **"Cornell-Dubilier Capacitor."** 16-page 5¼" × 7½" Vol. 11, No. 7 of this house organ features an article on the construction and circuit design of capacitor service instruments. Cornell-Dubilier Electric Corp., Hamilton Blvd., South Plainfield, N. J.

N-542 **"Uses Unlimited."** 2-page 8½" × 11" Vol. 2, No. 3 of this house organ features an article describing the use of the Micro Switch in controlling a lathe. Micro Switch, Freeport, Ill.

N-544 **"Wheelco Comments."** 4-page 8½" × 11" Vol. 5, No. 5 of this house organ features an article describing the use of automatic controllers on pottery kilns. Wheelco Instruments Co., Harrison & Peoria Sts., Chicago 7, Ill.

N-545 **"Bead Guide" Rotameter Tube.** 2-page 8½" × 11" Catalog Section 15-A pictures and describes the "Bead Guide" Rotameter Tube with longitudinal ribs on its inner face which obviate the need for float guide rods since they guide any float. Fischer & Porter Co., Dept. BG, Hatboro, Pa.

N-546 **Equipment for Mobile Recording.** 4-page 8½" × 11" bulletin pictures and describes "Model 110" Mobile Recording Assembly, designed for consultants and station engineers making proof of performance surveys for FM and television transmitter installations. Clarke Instrument Corp., 910 Jackson St., Silver Spring, Md.

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PROGRAM SUPPLEMENT

"Instrumentation for Tomorrow"

CONFERENCE AND EXHIBIT

OF THE

Instrument Society of America

HOTEL WILLIAM PENN

PITTSBURGH, PENNA.

SEPTEMBER 16-20, 1946

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ON THE COVER: "Everyone" is familiar with the Pittsburgh landmarks shown on the cover of this Program Supplement, but if you have forgotten they are: *(Background)* The Point, with the "Golden Triangle" embraced between the Allegheny and Monongahela Rivers; *(Top left)* Mellon Institute; *(Below)* Carnegie Institute with Carnegie Institute of Technology in the background; *(Circle)* University of Pittsburgh; *(Right)* William Penn Hotel.

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Technical Program

With Abstracts of Papers to Be Presented

MONDAY, SEPT. 16

2:00 p.m. Forum Room

I.S.A. Session on **Computing.** Technical Chairman, Dr. B. R. Teare, Carnegie Institute of Technology.

"Electrical Analogue Computers," by Clifford E. Berry, Consolidated Engineering Corporation, Pasadena, Calif.

ABSTRACT.—Various means of performing basic mathematical operations such as addition (subtraction), multiplication (division), integration, and differentiation by means of analogous electrical networks are discussed. It is shown how addition can be carried out both by series and parallel networks; multiplication by means of pairs of voltage dividers, one feeding the other; integration and differentiation by means of combinations of reactive elements (inductance or capacitance) with vacuum tube circuits.

Examples illustrating various combinations of basic methods for solving specific problems are discussed. These include continuous single or double integration of accelerations to give respectively velocity and displacement; a computer for solving stress-strain problems; and a computer for solving linear simultaneous equations.

"Continuous Computing Mechanisms," by Macon Fry, W. L. Maxson Corp., New York, N. Y.

ABSTRACT.—The paper will review the basic mechanisms involved in mechanical computation as exemplified by fire-control instruments.

MONDAY, SEPT. 16

2:00 p.m. Pittsburgh Room

A.S.M.E. Symposium on **Controllability of Combustion Processes.** Chairman, Ervin George Bailey, Bailey Meter Co. Recorder, Thomas E. Purcell, Duquesne Light Co., Pittsburgh.

"Uncontrollability Factors in Boiler Operation" by Joseph A. Pelletere, Gulf Oil Co., Pittsburgh, Pa.

ABSTRACT.—Introduction; Control Function; Uncontrollability Factors in Instruments; Uncontrollability Factors in Valves, etc.; Uncontrollability Factors as Result of Reversed Level Signal; Uncontrollability of Level as Result of Modern Economic Design; Difficulties of Using CO_2 Analyzer as Control Instrument; Coal Firing or Solid Fuel Rate Meters a Factor to be classed as Uncontrollability; Mixed Fuels Problem.

"Items of Controllability in the Open Hearth Combustion Process" by Andrew J. Fisher, Bethlehem Steel Co., Sparrows Point, Md.

ABSTRACT.—This paper will discuss the methods and problems relating to the recording and control of the various combustion items in the open hearth process. Specific items covered are: oil flow, steam pressure, air flow, furnace pressure, checker temperature, reverse cycle, flame radiation, and combustion air temperatures.

"The Blast Furnace—Chief Uncontrollable in All Industry" by Walter Flanagan, Carnegie-Illinois Steel Co., Pittsburgh, Pa.

"Combustion Control and Its Influence on Fuel-burning Equipment Design" by P. S. Dickey, Bailey Meter Co., Cleveland.

ABSTRACT.—Evolution of methods of burning fuels, developments leading toward automatic control of various combustion systems. Problems resulting from undesirable characteristics of certain fuels and efforts to overcome these problems. Effect of type of combustion system and of characteristics of fuel on basic design of combustion control. Functions of combustion control systems, advantages of different arrangements of control apparatus. Advantages and limitations of various methods for proportioning fuel and air. General description of types of measuring and controlling devices for automatic control with a comparison of advantages of different types.

TUESDAY, SEPT. 17

9:00 a.m. Pittsburgh Room

A.S.M.E. Session on **Gas Analysis Instrumentation.** Chairman, C. L. Willibald Trinks, Consulting Engineer, Pittsburgh. Recorder, Lester E. F. Wahrenburgh, Peter F. Loftus Co., Pittsburgh.

"Principles of Quantitative Gas Analysis and Testing" by Alfred William Gauger, The Pennsylvania State College, State College, Pa.

ABSTRACT.—Ideal method of gas analysis and testing is one that can be made in zero time at zero cost. Recorders approximate this ideal but involve initial investment, servicing and calibration. Gas analysis methods may be classified in two ways—According to nature of operations, such as absorption, distillation, chemical reaction, electrical, thermal, or other physical effects. According to type of measurement as volumetric, gravimetric, methods involving density, color, optical properties, etc. Not all methods are adaptable to industrial work, but the usefulness of any of them can be augmented by understanding the nature and behavior of gases as well as the useful specific techniques. Examples are given.

"Precision Analysis of Engine Exhaust Gas" by Charles W. Butler, M. J. Boegel and R. P. Jones, Gulf Research & Development Co., Harmarville, Pa.

ABSTRACT.—The paper will be brief. We do not intend to go into chemistry. . . . During the war, necessity forced us to spend considerable time to produce better-than-average results in determining combustion efficiency . . . a few tricks may be valuable to others.

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"NACA Gas Analysis Instrumentation for Aeronautical Engine Research" by William H. Haynie, and Harold C. Gerrish, NACA Engine Research Lab., Cleveland, Ohio.

ABSTRACT.—Problem of fuel-air ratio measurement for conventional and jet engines is so important in investigations of specific fuel consumption, range, and load, that all commercial gas analyzers have been investigated and new methods and instruments for analysis have been developed. A new fuel-air ratio indicator, whose operation depends on oxidation of normal exhaust gas, provides satisfactory indications throughout operating range of all types of aircraft engines. Separate analyzers have been built for conventional and jet engines. Either instrument has an accuracy of 2% of full scale. Other gas analysis instruments used by NACA include an oxygen analyzer utilizing magnetic susceptibility of oxygen, and various combustible gas and CO warning systems.

"Four New Methods of Industrial Gas Analysis" by H. D. Middel, General Electric Company, Schenectady, N. Y.

ABSTRACT.—1. Acoustic Gas Ana'yzer; 2. Mass Spectrometer; 3. Dew Point Recorder; 4. X-Ray Photometer. How these four new methods operate; advantages and limitations in process gas streams and in controlling process functions.

TUESDAY, SEPT. 17

9:30 a.m. Forum Room

I.S.A. Session on **Inspection and Gaging.** Technical Chairman, Lt. Col. W. J. Darmody, U. S. Army Ordnance Gage Laboratory.

"Surface Roughness Instrumentation and Factory Inspection," by Walter Mikelson, General Electric Co., Schenectady, N. Y.

ABSTRACT.—Elementary discussion of terminology most commonly used in industry. Commercially available instruments are described as well as a few special equipments and techniques used in America and other countries. The results of a survey made by the General Electric Company on instrumentation in the United States is included also. The development and application of Standard Roughness Specimens are described.

"Surface Finish Measurement Instrumentation," by J. A. Broadston, Surface Checking Gage Co., Hollywood, Calif.

ABSTRACT.—Actual examples taken from industry that the use of such instrumentation as is now available, together with a properly integrated system of drawing notation and correlated shop and inspection procedures, can result in appreciable cost savings, and improved product quality will be shown. The use of such equipment provides a valuable new working tool that has not yet been adopted by a large portion of manufacturing industry primarily because they do not realize its real worth.

Principles of operation of several instruments for measuring surface finish will be reviewed. Such instrumentation, while unquestionably contributing greatly to present progress in the field of surface measurement, is still a long way from perfection and the design of new instrumentation for the purpose still holds an open challenge to the instrument industry. Some of the problems as yet unsolved will be clearly shown. Some of the interesting though unsuccessful attempts at solving them will be reviewed. An effort will be made to provide instrument designers with enough basic information regarding surface finish instrumentation to develop new methods and instruments and thereby contribute to future progress in the field.

TUESDAY, SEPT. 17

2:00 p.m. Forum Room

I.S.A. Session on **Inspection and Gaging.** Technical Chairman, Rush Bowman, Precisioneering.

"Recent Trends in Electric Gaging Methods," by Howard C. Roberts, University of Illinois, Urbana, Ill.

ABSTRACT.—A résumé of the development of electric gaging methods, outlining the trend of techniques and of applications.

A suggestion for a coordinated development program, incorporating statements of operating characteristics of the commonly used methods, and of their advantages and disadvantages in use.

A semi-technical description (with demonstration if possible) of an electric gaging system of wide applicability—capable of operating from primary elements designed for measurement of dimension, pressure, temperature, velocity, and force, and for exploration and flaw-detection; designed to indicate its intelligence upon pointer-type instruments or to record either with magnetic galvanometers or upon a cathode-ray oscillograph.

"Location of Internal Defects in Materials by Supersonics," by J. W. Dice, Sperry Products, Inc.

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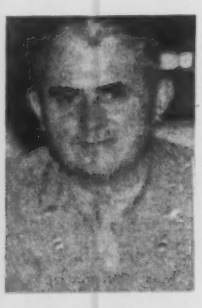

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ABSTRACT.—Background history development work employing sound waves in the supersonics range. Principle of operation of the Supersonic Reflectoscope with an explanation of how supersonic sound waves are generated and how they are introduced into the material being tested. Interpretation of defect indications which appear on the scope screen. Speed of sound waves through various classes of materials. Application to the testing of materials in the raw, semi-finished and finished stages, as well as to the testing of machine or equipment parts without disassembly of the equipment.

"Training in Inspection and Gaging," by Roger L. Geer, Cornell University, Ithaca, N. Y.

ABSTRACT.—One of the prime objectives of engineering education is mastery of the fundamental physical and mathematical laws and systems of measurement. Another important goal is training to perfect a sound sense of judgment and the perception of all factors involved in a situation.

The past war has made laymen "control conscious." Inspection (dimensional control) in industry became such an important phase of the War effort that service commands set up special training programs through E.S.M.W.T. and other agencies to train men and women to inspect matériel for the Armed Forces.

During the summer of 1942, Cornell University created a course in Measuring Instruments as a supplement to its Machine Tool Processes instruction. This paper describes the origin and development of the instructional material used in this course content, equipment outlay and arrangement. Dimensioning principles, A.S.A. and other commercial standards as well as machine tool inspection standards are included to effect a complete picture of the functions of inspection in the modern industrial plant. Various teaching aids such as models, charts, and films are enumerated and evaluated.

Integration of subject matter with courses in Engineering Drawing, Tool Engineering, Plant Layout, Quality Control, Cost Engineering, is emphasized.

TUESDAY, SEPT. 17

2:00 p.m. Pittsburgh Room

A.S.M.E. Session on Flow Measurement and Control. Chairman, Arthur J. Kerr, Rockwell Mfg. Co., Pittsburgh. Recorder, L. E. Hankinson, West Penn Power Co., Pittsburgh.

"Cascaded and Multiple Automatic-control Systems" by A. A. Markson and M. J. Boho, Hagan Corporation, Pittsburgh, Pa.

ABSTRACT.—Paper's scope is limited to pneumatically-operated industrial process control systems. "Cascaded Control System" denotes control circuits in which equilibrium requirements of primary regulation are determined or satisfied by the automatic resetting of associated regulators. "Multiple-element Control System" denotes an automatic-control system involving multiple-element regulation and other control functions. General considerations surrounding the engineering of such circuits are introduced. Apparatus elements are described. Illustrative examples are presented.

"The Positive Meter as a Flow-rate Control Device" by Eugene W. Jacobson, Chief Design Engineer, Gulf Research & Development Co., Harmarville, Pa.

ABSTRACT.—The positive displacement meter is an extremely accurate measuring device which can be used for flow control or related processes where close measurement is involved. So far, it has been developed chiefly for close measurement of liquid hydrocarbons and in one or two particular designs for close measurement of gases. The paper points out characteristics which may be useful in flow control.

"An Extension of Rotameter Theory and Its Application in New Practical Fields" by Victor P. Head, Fluids Research Engineer, Fischer & Porter Company, Philadelphia.

ABSTRACT.—The dynamic theory of the Rotameter has, up to the present time, not been fully developed and explored, with the result that additional possible engineering advances in flow-rate metering have not been realized. This paper endeavors to complete the dynamic theory of the Rotameter and to point out practical applications of the theory extension. A dynamic simulation technique is described which permits prediction of Rotameter calibration for any fluid from any other fluid. Novel and useful characteristics obtainable by arranging Rotameters for operating at supersonic fluid velocities are described. Elimination of compressibility as a variable affecting flow-rate meter calibration is described.

"Nozzle Flow Characteristics in Pneumatic Force-balance Circuits and Application to Automatic Flow-rate

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HAYNIE

JONES

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Control" by David B. Kirk, Moore Products Co., Philadelphia.

ABSTRACT.—Development of text is based on basic laws governing flow through an orifice. . . . Material applies directly to pneumatic circuits often encountered in measurement and control. This principle applied in a self-contained flow controller with favorable results in flow range from 1 to 10,000 ccpm. of air and equivalent ranges for other fluids.

WEDNESDAY, SEPT. 18

9:00 a.m. Pittsburgh Room

Joint I.S.A. and A.S.M.E. Session on **Automatic Control Terminology.** Chairman (for I.S.A.), J. C. Peters, Leeds & Northrup Co., Philadelphia. Recorder (for A.S.M.E.), Lyman M. Van der Pyl, Rockwell Mfg. Co., Pittsburgh.

"Graphic Representation and Analysis of Automatic-control Terminology" by Joseph G. Horn, Brown Instrument Company, Philadelphia, Pa.

ABSTRACT.—This paper will serve as an introduction to a discussion of automatic control terms and definitions proposed by the Industrial Instruments and Regulators Division, A.S.M.E. These terms, published in February, 1946, Mechanical Engineering, are available in convenient booklet form from A.S.M.E., 29 West 39th Street, New York 18, N. Y. Price 25 cents.

"Functional Analysis of Measurement Apparatus" by H. C. Dickenson, General Electric Co., West Lynn, Mass.

ABSTRACT.—This paper covers a logical and practical method of analyzing all types of measurement apparatus, which has been developed after several years of study and is actually in use. To emphasize the fundamentals of measuring equipment this method deals with the functions and functional elements that are necessary steps in the flow of measurement energy from the initial operation to the final result, which is either an indication, a record, or the initiation of a control sequence. In working out the method it has been necessary to provide new terms and definitions for the various functional parts and also to carefully define other terms that are in common use. In the paper, a number of measurement systems are analyzed to illustrate the method described. Statistical data on the functional elements are also shown and bring out the interrelation of the equipment used for widely diversified measurements. The benefits already obtained include a better understanding of individual measurement systems and a clearer appreciation of the whole measurement field. In addition, this method was proved to be of considerable assistance in coordinating engineering activities, such as the standardization of product designs, the appraisal of similar types of measuring equipment and the indexing of information and data. It is hoped that through a wider use of the proposed method, a common and consistent language of measurement will be evolved.

WEDNESDAY, SEPT. 18

9:30 a.m. Cardinal Room

I.S.A. Session on **Measurement and Control.** Technical Chairman, Ralph Webb, Carbide and Carbon Chemicals Corp.

"Design of Instrument Air Supply Systems for the Process Industry," by W. C. Ludi, Standard Oil Development Co., Linden, N. J.

ABSTRACT.—The purpose of this paper is to outline the principal points and the present day practices being followed in the oil industry in the design of an instrument air supply system. When air systems are used which do not meet the fundamental requirements, unsatisfactory operation is experienced resulting in a bad moral effect on the operating personnel and loss of confidence in the ability of the control instruments to function properly. By the use of a satisfactory air supply system, handsome returns may be expected on the investment.

For purposes of design, basic engineering data are given on pressure requirements, instrument air consumption, both instrument-wise and unit-wise and air dryness to prevent moisture troubles. Also included are principal design features desired in the mechanical equipment used in the system.

"Two Step System for Automatic Neutralization of Large Scale Processes," by Phil Ewald, Tennessee Valley Authority.

ABSTRACT.—Automatic neutralization is usually carried out in a single step with sufficient supply regulation and mixing to permit instrument control within the desired limits. In the process described, the large scale neutralization of nitric acid

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with ammonia, the use of a two step system provided stable control and ease of operation without the supply and mixing requirements being met.

"Design of Thermocouple and Thermometer Wells," by George R. Feeley, Trinity Equipment and Supply Co.

WEDNESDAY, SEPT. 18
2:00 p.m. Cardinal Room

I.S.A. Session on **Measurement and Control.** Technical Chairman, F. H. Trapnell, E. I. duPont de Nemours & Co., Inc.

"Process Unit Control Instruments—Their Installation and Initial Operation," by Harry F. Moore, Standard Oil Development Co., Linden, N. J.

ABSTRACT.—The best of application engineering and equipment selection does not by itself guarantee satisfactory performance of process unit instrumentation. This is obvious. Nevertheless, all too frequently the installation amounts to little more than bolting the control instrument items to their supports and running the necessary pipes, tubes and wires to them. Similarly preparation for their initial operation may consist of such actions as turning the proper valves on manometer type equipment, turning on the 110 volt supply to the pyrometers, and opening the air supply to the controllers. This paper outlines practices which correct this situation and result in control instruments being "ready to go" when the process unit starts operating.

"Some Considerations in the Control of Continuous Processes," by H. C. Frost, Corn Products Refining Co., Argo, Ill.

ABSTRACT.—This paper "designs" a hypothetical process from the initial requirements to the final choices of all indicating, recording and controlling instruments. It concludes with seven practical "don'ts."

WEDNESDAY, SEPT. 18
2:00 p.m. Pittsburgh Room

I.S.A. Session on **Instrument Research.** Technical Chairman, M. F. Behar, Instruments Publishing Co.

"Instrument Developments in Britain," by H. B. Cronshaw, London, England.

"An Institute for Instrument Research," by R. H. Müller, New York University, N. Y.

ABSTRACT.—The reasons for the need of an Institute of this character will be summarized. It is increasingly apparent that the full needs of professional training in instrumentation cannot be met by occasional and random additions to science and engineering curricula. The cost of an adequate program is prohibitive in most cases. Until a complete program, including the entire field of instrumentation, is set up, the solution to the problem will remain unsatisfactory. The needs of long-term fundamental research in instrumentation are of almost equal importance.

There is little unanimity of opinion on these questions, and the speaker will attempt to analyze the diverse views and relate them to the present situation.

American pre-eminence in instrumentation cannot be maintained if adequate instruction and fundamental research are neglected or left to chance.

"The Biography of a Research Project from Cradle to Maturity," by Paul G. Weiller, Engineering Consultant.

ABSTRACT.—This paper is the story of the development of an electronic temperature control from its accidental conception to the field test on the finished instrument. It describes the step-by-step method by which a casual observation was turned into a useful development.

THURSDAY, SEPT. 19
9:30 a.m. Cardinal Room

I.S.A. Session on **Measurement and Control.** Technical Chairman, E. J. Grace, Sun Oil Co.

"Some Problems Affecting Instrumentation in the Chemical Process Industries," by A. L. Chaplin, American Cyanamid Co.

ABSTRACT.—Paper will consider methods of measurement and control applied in batch and continuous processes, comparing various types of measuring devices, mechanical, electrical and physico-chemical.

"Temperature Control of Reactors for Synthetic Rubber," by E. E. Rowland, The University of Akron.

ABSTRACT.—In 1943-4, when the standard plants for producing GR-S were erected throughout the country, it appeared that for temperature control of the reactors an instrument with proportional band adjustment and reset would perform satis-

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factorily. The problem, however, is far more complex than the original simplifying assumption. It was found upon starting the reactors that a controller with optimum settings of proportional band and reset was unsatisfactory. It was found necessary to incorporate the second derivative action into the controller to give satisfactory results. As the second derivative is a function of the reset rate, it was found best to use a greater second derivative action than has been considered optimum in most other cases. As expected, the controlled valve positioning was a little ragged, but the batch temperature was held to within ¼° F. It was necessary to control in such a manner as to give a steady temperature difference across the jacket of the reactor, for a differential Thermohm recorder was used to obtain data on the heat evolution of the various lattices. Another difficulty lay in the fact that the cooling water temperature, at times, varied several degrees. Both requirements were met by adding a second temperature controller affected directly by the jacket temperature and positioned pneumatically by the primary instrument. The primary instrument was set at 30% throttling range, with extremely long reset time, and high second derivative. The secondary instrument at 40% to 50% throttling range, with no second derivative and normally fast reset rate, tends to smooth out impulses of the primary as well as cooling-water temperature variations. This combination has given excellent results.

THURSDAY, SEPT. 19

9:30 a.m. Pittsburgh Room

I.S.A. Session on **Scientific Instruments.** Technical Chairman, D. F. Windenburg, David Taylor Model Basin, U. S. Navy.

"Manometers for Extremely Low Pressures," by Saul Dushman, General Electric Co., Schenectady, N. Y.

ABSTRACT.—A few of the principal types of gages, which are used for measuring pressures in the range of interest to those engaged in vacuum technique, will be described briefly.

"An Elastic-tube Gage for the Measurement of Static and Dynamic Pressures," by Edward Wenk, Jr., David Taylor Model Basin, U. S. Navy.

ABSTRACT.—It contains a description of an elastic-tube gage with strain-wire sensitive elements developed at the Taylor Model Basin for the measurement of a wide range of static and dynamic pressures associated with naval ordnance mechanisms. A detailed discussion is given of the operating requirements, novel features of the mechanical and electrical components, auxiliary electrical and recording equipment, calibration techniques, and gage characteristics such as sensitivity, accuracy, and response to transient pressures. Several sample records are given comparing the elastic-tube pressure gage with piezoelectric crystal and mechanical indicator types of pressure measuring equipment.

THURSDAY, SEPT. 19

2:00 p.m. Cardinal Room

I.S.A. Session on **Plant Instrument Practices.** Technical Chairman, Phil Ewald, Tennessee Valley Authority.

"Organization of the Instrument Division at Canada's Synthetic Rubber Plant," by J. W. Graeb, Polymer Corporation, Ltd., Sarnia, Ontario, Canada.

ABSTRACT.—The paper will describe the internal organization of the Instrument Division and the relation of the Instrument Division to other departments in the plant. It will include in some detail the scope of work handled by the Instrument Division, a description of the maintenance and training programs being carried on and will mention some details of the special equipment developed or used by the Division.

"Organization of a Research Laboratory Instrument Department," by Paul Exline, Gulf Research and Development Co.

THURSDAY, SEPT. 19

2:00 p.m. Pittsburgh Room

I.S.A. Session on **Scientific Instruments.** Technical Chairman, C. O. Fairchild.

"Spectroscopy in the Petroleum Industry," by S. C. Fulton, Esso Laboratories.

ABSTRACT.—Rapid progress has been made over the past few years in the application of spectroscopy to the analytical problems currently encountered in both research and process control in the petroleum industry. Infrared, ultraviolet, Raman, mass and emission spectroscopy have been found to be of parti-

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cular value and with these tools it is possible to quantitatively analyze a large number of complex mixtures for the individual components. In many cases it is not possible to do these analyses by conventional methods and in general where conventional methods are competitive spectroscopy permits large savings in time.

The status of the progress that has been made in hydrocarbon analysis is revieved with the instrumentation required for various types of compounds. Following a brief discussion of the principles involved, a typical example is used to illustrate the development of analytical procedures based on absorption spectroscopy.

The use of infrared, ultraviolet and mass spectroscopy in the analysis of hydrocarbon gases is reviewed with data illustrating where these methods can be applied. Liquid hydrocarbons are also covered in the same way for a number of typical examples. Particular emphasis is given to emission spectroscopy and its application to the rapid analysis of trace impurities in hydrocarbon conversion catalysts and inorganic compounds in crude oils.

The paper is concluded by a review of the status of instrument development indicating where improvements in design are required.

"Sound and Vibration Measurement," by H. A. Leedy, Armour Research Foundation, Chicago, Ill.

ABSTRACT.—Sound measuring instruments, principally sound level meters and sound level recorders will be discussed. Information will be given concerning the best designs of such instruments and how they can be made to respond to what the ear hears. Applications of such instruments, as well as examples of particular uses will be discussed. A brief discussion will also be included concerning the design and application of vibration measuring instruments for the measurement of vibration amplitude, velocity and acceleration.

THURSDAY, SEPT. 19

8:00 p.m. Cardinal Room

I.S.A. Session on **Measurement and Control.** Technical Chairman, M. H. White, Atlantic Refining Co.

"Demonstration of Principles of Automatic Control," by Gerald F. Akins, John Kowalski, and Norman Koenig, Eastman Kodak Co.

THURSDAY, SEPT. 19

8:00 p.m. Pittsburgh Room

Joint Physical Society of Pittsburgh, I.S.A. Session on **Instrumentation in Atomic Energy Research.** Technical Chairman, I. Estermann, Carnegie Institute of Technology.

"Controls on the Chain Reacting Pile," by E. Creuz, Carnegie Institute of Technology.

"Remote Control of Chemical Laboratories Dealing with Intense Radiations," by C. R. Schwob, Carnegie Institute of Technology.

"Protection of Personnel," by Fitzhugh Marshall, Westinghouse Research Laboratories.

FRIDAY, SEPT. 20

9:30 a.m. Forum Room

I.S.A. Session on **Instrument Components and Materials.** Technical Chairman, Paul Exline, Gulf Research and Development Co.

"Relays," by C. A. Packard, Struthers-Dunn, Inc.

"Springs," by John Rockefeller, Jr., All Weather Springs.

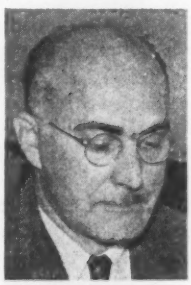
FRIDAY, SEPT. 20

9:30 a.m. Cardinal Room

I.S.A. Session on **Aviation Instruments.** Technical Chairman, W. G. Brombacher, National Bureau of Standards.

"Requirements of Dynamics Test Equipment for Certain Aircraft Applications," by Lee S. Wasserman, Air Matériel Command, Wright Field, Dayton, Ohio.

ABSTRACT.—The paper covers problems in the use of dynamics measuring equipment encountered by the Dynamics Branch, Aircraft Laboratory, Air Matériel Command. The specific applications of this equipment discussed include the measurement of: The dynamic loads on aircraft structures caused by landing impacts; aircraft structural vibrations caused by flutter and buffeting, hydraulic pressure fluctuations in aircraft systems, cannon recoil loads, and glider tow rope loads. The type of instrumenta-


FULTON

ROCKEFELLER

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FROST

ROWLAND

BEYER

SPEAKERS I.S.A. SESSIONS

tion employed in the various tests is described, the limitations of the equipment are discussed, and the corrective action taken or recommended is outlined. Finally a brief résumé is given of current Air Matériel Command specifications for dynamic measuring equipment needed for present and future applications.

"Specialized Instrumentation for Flight Testing," by Joseph P. Paine, The Glenn L. Martin Co.

ABSTRACT.—The paper discusses the instrumentation and techniques used for the measurement of aircraft flight test data. The first part of the paper is devoted to the measurement of slowly varying conditions of pressures, temperatures, air-speeds, and related quantities. Specific methods and instruments are examined in detail, many of which have been developed by The Martin Company during the past few years. The relative merits of accepted methods of measurements are considered.

The second section of the paper is concerned with the problems of dynamic load measurements. Automatic recording of rapidly varying strains, accelerations, positions, and similar quantities is discussed. Requirements and limitations of recording equipment used for such measurements are analyzed.

In conclusion, the trend of experimental flight instrumentation toward telemetering and radio control is mentioned.

"Automatic Pilots," by J. C. Newton, Sperry Gyroscope Co.

ABSTRACT. — Non-mathematical discussion of the fundamental principles involved in determining the requirements for a modern gyro-pilot system, and in developing means for fulfilling these requirements.

FRIDAY, SEPT. 20

2:00 p.m. Forum Room

I.S.A. Session on **Instrument Components and Materials.** Technical Chairman, William Wildhack, National Bureau of Standards.

"How Special Metals Solve Instrument Problems," by Robert W. Carson, Instrument Specialties Co., Inc., Little Falls, N. J.

ABSTRACT. — For ordinary engineering materials, readily available sources provide adequate data on such properties as hardness, tensile strength, elastic limit and endurance. But in many instrument problems density, modulus, thermal expansion, electrical and magnetic characteristics are of much greater importance. Many of the lesser known metals and their alloys offer ranges and combinations of properties of advantage in instrument design.

Such information is widely scattered, incomplete and sometimes not too consistent. But approximate values are offered along with some suggestions for instrument design applications where the special combination of properties available may be useful.

"Future Trends in Instrument Bearings," by J. H. Goss, General Electric Co., West Lynn, Mass.

ABSTRACT.—Instrument bearings were in a large measure borrowed from the practices of the watch and clock industry which was, of course, old in years when electrical instruments were born.

The last decade which includes the war years has brought a tremendous expansion in the field of electrical measurements and a great increase in the service requirements of instruments. Instrument bearings have been the subject of much investigation and development. The problems have ranged from the severe and prolonged vibration of instruments in aircraft service to the severe shock of instruments aboard ship under conditions of gunfire and bombing.

The purpose of this paper is to review progress and to attempt to point out trends for the next few years.

FRIDAY, SEPT. 20

2:00 p.m. Cardinal Room

Naval Ordnance Session. Technical Chairman, Nelson Gildersleeve, General Electric Co.

"Audio-frequency Q-meter," by M. J. Relis, Naval Ordnance Laboratory, U. S. Naval Gun Factory.

ABSTRACT.—An audio-frequency Q-meter of new design has been developed, making possible measurements of inductive and capacitive reactances with Q's in the range from 1 to 500, over the frequency range from 100 to 20,000 cycles per second. Q can be determined with an accuracy of ± 1%, but changes in Q of 0.01% can be measured. The range of inductance or capacitance that can be measured depends on the range of available standards. With this Q-meter inductances can be measured with 50 volts r.m.s. a-c. across them, and by a simple expedient they can also be measured with a d-c. polarizing current for determination of the incremental inductance. Unlike conventional Q-meters, this is a null instrument and possesses the higher precision of which such instruments are capable. It is therefore very sensitive to small changes in reactance or Q, making it extremely effective in substitution measurements. The Q-meter is mounted on a standard relay rack with the associated equipment, which consists of an oscillator, power amplifier, null amplifier, and indicator.

"Switch Interval Timer," by H. T. Gittings, Naval Ordnance Laboratory, U. S. Naval Gun Factory.

ABSTRACT.—A timer has been developed to measure various time intervals associated with switch and relay operations. The basic circuit consists of a condenser which is partially charged during the time interval to be measured. Since, for times up to one tenth the time constant of a circuit, the voltage across the condenser increases linearly with time, a VTVM across the condenser can be calibrated directly in time units. Nine scales are provided from 250 microseconds to 2.5 sec. The input impedance of the VTVM is so high that the rate of discharge of the condenser through it is negligible. This results in a steady meter reading which can be read when convenient. Types of circuits which can be timed are: operation of two switches, either one of which may be normally open or closed; momentary operation of a contact, either open or closed; pick up or drop out time for a relay; and the transit time of a SPDT contact. Provisions are made to use the VTVM separately with an input impedance of 3000 megohms.

"Automatic Terminal Board and Cable Test Set," by J. M. Norton, Naval Ordnance Laboratory, U. S. Naval Gun Factory.

ABSTRACT.—The test set described in this paper was designed to test a maximum of 43 circuits during one testing cycle. During the testing cycle each circuit is checked twice for continuity and leakage resistance. High circuit resistance (above approximately 1 ohm), discontinuity, or leakage resistance of less than 50 megohms will cause the testing cycle to terminate. The faulty conditions are indicated by means of a series of panel lamps, which designate the cause and circuit. The test set compares the circuit to be tested against a standard or prototype circuit, thus providing extreme flexibility. Stepper switches, relays, tubes and other electronic components are mounted within the cabinet which measures 11″ x 13″ x 19″. Selector switches and 46 indicating lamps are mounted on the panel.

"Six-trace Cathode Ray Oscillograph," by G. L. Beyer, Naval Ordnance Laboratory, U. S. Naval Gun Factory.

ABSTRACT.—The description of a general purpose six-trace cathode ray oscillograph is presented. The oscillograph has a built-in recorder which photographs the spots of eight 2″ cathode ray tubes that are mounted side by side in a line. Six of these tubes have individual high-gain d-c. amplifiers, whose frequency response is flat to 30 kc. The two outside tubes are used for time calibration. The recorder has a fast wide-angle lens and uses up to 100 feet of standard 35 mm. film. The film can be driven at variable speeds up to 15 feet per second. A mechanical synchronizer is provided for use with drum operation of the recorder. Other features include an internal sine-wave oscillator with vacuum tube voltmeter for calibration, a tilting system for film and exposure identification, and a visual mirror sweep. The oscillograph is complete in two portable units.

Schedule of Educational Lectures

Dr. B. R. Teare (Carnegie Institute of Technology) in Charge

ELECTRICAL MEASUREMENTS—Adonis Room

Committee in Charge: L. F. Parachini (Weston Electrical Instrument Corp.), F. C. Ashe (Carnegie Institute of Technology), F. S. Adkins (Westinghouse Electric Corp.), H. S. Day (General Electric Company).

TUESDAY, SEPT. 17

9:00 a.m.—**Fundamental Electrical Indicating Instrument Mechanisms,** by G. R. Patterson (Carnegie Institute of Technology).

2:00 p.m.—**Instrument Accessories and Auxiliary Devices,** by L. F. Parachini (Weston Electrical Instrument Corp.).

WEDNESDAY, SEPT. 18

9:00 a.m.—**Recorders and Integrating Devices,** by H. S. Day (General Electric Co.).

2:00 p.m.—**Industrial Test Equipment,** Speaker to be announced.

INDUSTRIAL INSTRUMENTS—Adonis Room

Committee in Charge: Malcolm B. Hall (Foxboro Company), William G. Baker (Monsanto Chemical Company), Charles B. Cochran (Westvaco Chlorine Products Corp.), Hugh E. Ferguson (Peoples Gas Light & Coke Co.), Jack J. Gordon (Tennessee Eastman Corp.), George E. Heller (Taylor Instrument Cos.), John G. Kirkpatrick (Koppers Company, Inc.), C. E. Mason (Bristol Company), J. C. Mouzon (Brown Instrument Co.), D. C. Saylor (Carnegie Institute of Technology).

THURSDAY, SEPT. 19

9:00 a.m.—**Pressure and Thermal Systems,** by George E. Heller (Taylor Instrument Cos.).

2:00 p.m.—**A B C of Automatic Control,** by C. E. Mason (Bristol Co.).

FRIDAY, SEPT. 20

9:00 a.m.—**Flow and Liquid Level,** by L. K. Spink (Foxboro Co.).

2:00 p.m.—**Electrical Temperature Measurements,** by Martin L. Ladden (Brown Instrument Co.).

INSPECTION AND GAGING—Forum Room

Committee in Charge: Rush Bowman (Precisioneering), Lt. Col. W. J. Darmody (Director, U. S. Army Gage Laboratory), Casper Goffman (Westinghouse Electric Corp.), Keith R. Bronson (Kearney Works, Western Electric Co.).

WEDNESDAY, SEPT. 18

9:00 a.m.—**Tolerance Systems of Gage Design,** by Lt. Col. W. J. Darmody, Dir. U. S. Army Gage Lab.

2:00 p.m—**Automatic Inspection or Gaging,** Speaker to be announced.

THURSDAY, SEPT. 19

9:00 a.m.—**Gaging Instrumentation and Quality Control,** by J. Manuele, Westinghouse Electric Corp.

2:00 p.m.—**Your Inspection Dollar,** by Rush Bowman, Precisioneering.

What to Do in Pittsburgh

For further information see the Committee in Booth 178.

HOTELS

William Penn, William Penn Way: French Room, Wm. Penn Grill, Continental Bar, Men's Bar.

Roosevelt, Penn Ave. and 6th St.: Fiesta Room, Hideaway Bar, Fiesta Bar, Coffee Shop.

Fort Pitt, Penn Ave. and 10th St.: Norse Room, Lounge Bar, Stockade Bar.

Henry, 5th Ave. and William Penn Way: Silver Grill, Gay Nineties Lounge, Henry Bar, Fortune Bar.

RESTAURANTS

Childs, 351 5th Ave.

Dimlings, 24 Graeme St. (at Diamond Market).

Fontanas, 216 Stanwix St.

Darios, 218 Stanwix St.

Gammons, 954 Liberty Ave.

Hofbrau, 25 Graeme St. (at Diamond Market).

Kleins, 330 5th Ave.

Kramers, 208 6th Ave.

Little Luncheon, 212 Oliver Ave.

Nixon, 425 6th Ave.

Oliver, 527 Smithfield St.

Union Grill, Diamond at Grant St.

Stouffers, 531 Penn Ave., 421 Wood St., 618 Smithfield St.

SHOWS AND SPORTING EVENTS

"Ice Capades," at the Gardens, all week.

Football, night game, Chicago Cardinals vs. Pittsburgh Steelers, Forbes Field, Friday, Sept. 20.

Buhl Planetarium, Federal and E. Ohio St., North Side. A Special Exhibition is being planned for I.S.A. members and their guests. Details will be announced later.

Nixon, 6th Ave. (Stage): "Follow the Girls" with Gertrude Niessen.

MOTION PICTURE THEATRES

Stanley, 207 7th St.

Penn, 6th St. & Penn Ave.

J. P. Harris, 119 6th St.

Fulton, 101 6th St.

Warner, 336 5th Ave.

Senator, 956 Liberty Ave.

Harris Newsreel, 338 Diamond St.

CHURCHES

First Baptist of Pittsburgh, Bayard & Bellefield Sts.

St. Paul's Cathedral (Roman Catholic), 5th Ave. and Craig St.

St. Mary of Mercy (Roman Catholic), Blvd. of the Allies and Ferry St.

Trinity Episcopal, 6th Ave. near Wood St.

Rodef Shalom, 4095 5th Ave.

Beth Shalom, 5915 Beacon St.

Christian Science, 635 Clyde St.

First Lutheran, Grant St. near 6th Ave.

Methodist Center, 7th Ave. & Smithfield.

First Presbyterian, 6th Ave. near Wood St.

German Evangelical, 620 Smithfield St.

First Unitarian, Morewood St. and Ellsworth Ave.

Epiphany (Roman Catholic), 1018 Epiphany St.

FRATERNAL ORGANIZATIONS

Moose, Allegheny Lodge No. 47, 11 E. North Ave., N. S.

Elks, No. 11, 425 Penn Ave.

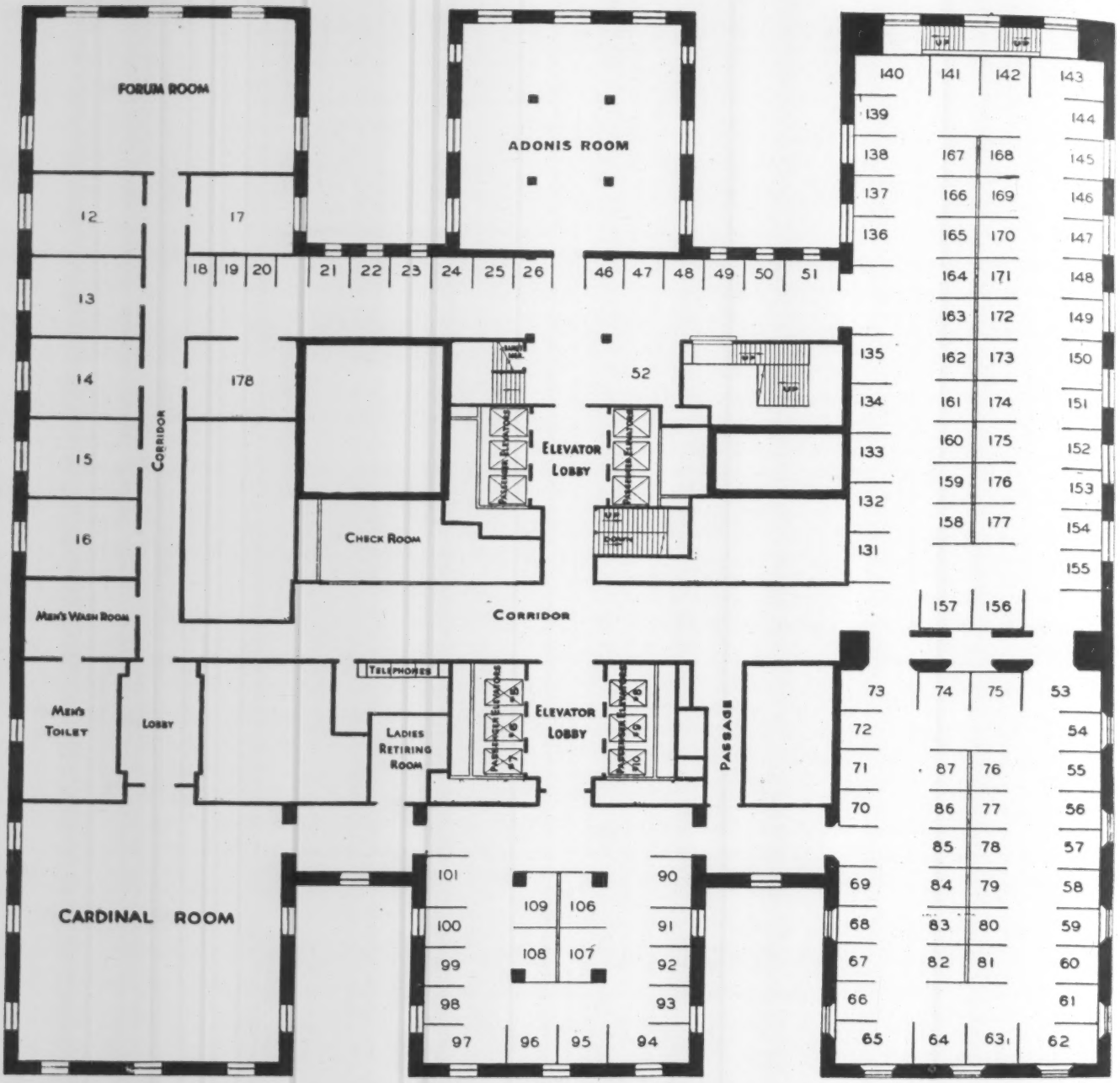
Masonic Temple, 4227 5th Ave.

Eagles, No. 76, 431 3rd Ave.

American Legion, No. 41, 1207 East St., N. S.

Knights of Columbus, No. 491, Fort Pitt Hotel.

A **Ladies' Program** has not been definitely formulated at this time. Please contact the Committee in Booth 178 for further information.



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Complete Calendar of Events

SUNDAY, SEPT. 15

10:00 a. m.—I.S.A. Nominating Committee Meeting—Booth 16.
2:00 p. m.—I.S.A. Board of Directors Meeting—Booth 16.

MONDAY, SEPT. 16

9:00 a. m.—I.S.A. Speakers' Breakfast—Booth 16.
9:30 a. m.—I.S.A. Get-together—Forum Room.
9:30 a. m.—A.S.M.E.—I.I.R.D. Executive Committee Meeting with Members of the Committee on Papers—E.S.W.P. Board Room, William Penn.
10:00 a. m.—I.S.A. Educational Committee Meeting—Adonis Room.
12:00 noon—A.S.M.E. Luncheon—Cardinal Room.
2:00 p. m.—Exhibit opens—17th floor.
2:00 p. m.—I.S.A. Computing Session—Forum Room.
2:00 p. m.—A.S.M.E. Symposium on Controllability of Combustion Processes—Pittsburgh Room.
7:00 p. m.—A.S.M.E. Banquet—English Room, Fort Pitt Hotel.
10:00 p. m.—Exhibit closes.

TUESDAY, SEPT. 17

8:00 a. m.—I.S.A. Speakers' Breakfast—Booth 16.
9:00 a. m.—A.S.M.E. Gas Analysis Instrumentation Session—Pittsburgh Room.
9:00 a. m.—I.S.A. Educational Course: Electrical Instruments—Adonis Room.
9:30 a. m.—I.S.A. Inspection and Gaging Session—Forum Room.
12:00 noon—Exhibit opens.
12:00 noon—A.S.M.E. Luncheon—Cardinal Room.
2:00 p. m.—I.S.A. Educational Courses: Electrical Instruments Adonis Room.
2:00 p. m.—I.S.A. Inspection and Gaging Session—Forum Room.
2:00 p. m.—A.S.M.E. Flow Measurement and Control Session—Pittsburgh Room.
6:30 p. m.—A.S.M.E.-I.I.R.D. Committee on Bibliography and Translations Meeting—Parlor K-9, Hotel Henry.
7:30 p. m.—A.S.M.E.-I.I.R.D. Committee on Application Meeting—E.S.W.P. Private Dining Room.
10:00 p. m.—Exhibit closes.

WEDNESDAY, SEPT. 18

8:00 a. m.—I.S.A. Speakers' Breakfast—Booth 16.
9:00 a. m.—I.S.A. Educational Course: Electrical Instruments—Adonis Room.
9:00 a. m.—I.S.A. Educational Course: Inspection and Gaging—Forum Room.
9:00 a. m.—Joint I.S.A.-A.S.M.E. Session on Terminology—Pittsburgh Room.
9:30 a. m.—I.S.A. Measurement and Control Session—Cardinal Room.
12:00 noon—Exhibit opens.
12:00 noon—I.S.A. Secretaries' Luncheon.
1:30 p. m.—A.S.M.E.-I.I.R.D. Committee on Papers Meeting—E.S.W.P. Board Room.
2:00 p. m.—I.S.A. Educational Course: Electrical Instruments—Adonis Room.
2:00 p. m.—I.S.A. Educational Course: Inspection and Gaging—Forum Room.
2:00 p. m.—I.S.A. Measurement and Control Session—Cardinal Room.
2:00 p. m.—I.S.A. Instrument Research Session—Pittsburgh Room.
3:00 p. m.—A.S.M.E.-I.I.R.D. Committee on Terminology Meeting—E.S.W.P. Board Room.
3:00 p. m.—A.S.M.E.-I.I.R.D. Committee on Theory Meeting—E.S.W.P. Private Dining Room.
4:00 p. m.—Exhibit Closes.
5:30 p. m.—I.S.A. Annual Meeting—Pittsburgh Room.
7:30 p. m.—I.S.A. Buffet and Entertainment—Pittsburgh Room.

THURSDAY, SEPT. 19

8:00 a. m.—I.S.A. Speakers' Breakfast—Booth 16.
9:00 a. m.—I.S.A. Educational Course: Industrial Instruments—Adonis Room.
9:00 a. m.—I.S.A. Educational Course: Inspection and Gaging—Forum Room.
9:30 a. m.—I.S.A. Measurement and Control Session—Cardinal Room.
9:30 a. m.—I.S.A. Scientific Instruments Session—Pittsburgh Room.
12:00 noon—Exhibit opens.
2:00 p. m.—I.S.A. Educational Course: Industrial Instruments—Adonis Room.
2:00 p. m.—I.S.A. Educational Course: Inspection and Gaging—Forum Room.
2:00 p. m.—I.S.A. Plant Instrument Practices Session—Cardinal Room.
2:00 p. m.—I.S.A. Scientific Instruments Session—Pittsburgh Room.
8:00 p. m.—Joint Physical Society of Pittsburgh-I.S.A. Session: Instrumentation in Atomic Energy Research—Pittsburgh Room.
8:00 p. m.—I.S.A. Measurement and Control Session—Cardinal Room.
10:00 p. m.—Exhibit Closes.

FRIDAY, SEPT. 20

8:00 a. m.—I.S.A. Speakers' Breakfast—Booth 16.
9:00 a. m.—I.S.A. Educational Course: Industrial Instruments—Adonis Room.
9:30 a. m.—I.S.A. Instrument Components and Materials Session—Forum Room.
9:30 a. m.—I.S.A. Aviation Instruments Session—Cardinal Room.
12:00 noon—Exhibit opens.
2:00 p. m.—I.S.A. Educational Course: Industrial Instruments—Adonis Room.
2:00 p. m.—I.S.A. Instrument Components and Materials Session—Forum Room.
2:00 p. m.—I.S.A. Naval Ordnance Session—Cardinal Room.
4:00 p. m.—Exhibit Closes.

Descriptive List of the Exhibits
and Personnel in Attendance

Aircraft-Marine Products Inc., 1524 N. 4th St., Harrisburg, Pa. Booth **97.**

Exhibiting: Pneumatic Hand Tool to apply terminals and connectors to electric wires; pre-insulated line of terminals and connectors; Solastrand terminals and connectors; corrosion-proofed connections.

In attendance: J. P. Flynn, Sales Pro. Mgr.; H. J. Giles, Spec. Rep.; G. L. Herrick, Div. Mgr.

Alien Property Custodian, Washington 25, D. C.

Exhibiting: Abstracts and copies of vested and actual patents in the possession of the Custodian.

In attendance: Dexter North, Chief Patent Use & Dev. Sect.

American Meter Co., Inc., 920 Payne Ave., Erie, Pa. Booth **64.**

Exhibiting: Reset Flow Controller, Air Actuated Remote Reset Flow Controller, Recording Orifice Meter, Integrating Orifice Meter.

In attendance: A. F. Benson, Chief Engr.; A. B. Cloud, Engr.; Alex Chatfield, Engr.; Douglas Kramer, Engr.; H. V. Beck, Engr.

Askania Regulator Co., 1603 S. Michigan Ave., Chicago 16, Ill. Booths **93-94.**

Exhibiting: Position Servo System; a new method of measuring and controlling viscous fluids and other liquids; the first public demonstration of the new Askania Self Balancing Beam Tube; an air coupled hydraulic unit which will follow the contour of templates; Jet Pipe Hydraulic Regulators for pressure, flow, and proportioning.

In attendance: H. J. Velten, Pres.; H. Ziebolz, V. P. in chg. of engr.; Paul Glass, Res. Engr.; Clark Hague, Dist. Mgr.; E. R. Engstrom, Mgr. Pgh. Dist.; W. F. Pray, Adv. Mgr.

The Autotron Co., 128 W. Main St., Danville, Ill. Booth **98.**

Exhibiting: High Speed Production Counter, Electronic Inspection Machines.

In attendance: J. T. Fuhrman, Jr.

Ballantine Laboratories, Inc., Boonton, N. J. Booth **132.**

Exhibiting: Model 304 Sensitive Electronic Voltmeter; Standard Model 300 Sensitive Electronic Voltmeter; Model 302 Sensitive Electronic Voltmeter, and accessories for these instruments.

In attendance: Frank R. Zayac, Gen. Mgr.; Edmund Osterland, Chief Engr.

James G. Biddle Co., 1211 Arch St., Philadelphia 7, Pa. Booth **92.**

Exhibiting: Magnet Tester for testing permanent magnets from 8 gauss upwards; Reed Frequency Monitor utilizing vibrating reed to actuate signal or alarm when frequency variation exceeds 0.1 cps. on 60 cps.; "Megger" Insulation Resistance Testers, hand and motor driven, U.S.-made "Meg" and Midget types; "Jagabi" Lubri-tact Laboratory Slide-wire Rheostats; "Frahm" Vibrating-Reed Frequency Meters and Tachometers; "Jagabi" Speed Indicators, Tachometers and Tachoscopes.

In attendance: H. A. Eysenbach, Engineering Dept.

Brookfield Engineering Laboratories, 156 Massapoag Ave., Sharon, Mass. Booth **80.**

Exhibiting: Small Laboratory Mixers; new flexible shaft for use with Viscosimeter; Brookfield Synchro-Lectric Single-speed and four speed viscosimeters.

In attendance: G. W. Brookfield, Treas.; D. W. Brookfield, Res. Dir.

Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio. Booths **71-72.**

Exhibiting: New BL-103 Surface Analyzer, utilizing new Brush Magnetic Oscillographs; D-c. Amplifier for use with magnetic oscillographs; BL-502 Transient Recorder featuring external triggering and 0.2 transient recording; single-, double- & six-channel oscillographs; Vibration Pickups; Heart Beat Pickups; all accessories for Surface Analyzer.

In attendance: M. P. Odell, Mgr. Instrument Dept.; C. O. Novorska, Instrument Dept.; E. M. Hensley, Instrument Dept.; H. A Stearns, Instrument Dept.

Burgess Battery Co., Freeport, Ill. Booth **81.**

Exhibiting: Dry Batteries for electronic instrument applications.

In attendance: M. J. Johnson, Sales Engr.; T. F. Heberling, Rep.; L. H. Harriss, Sales Mgr.

Burling Instrument Co., 253 Springfield Ave., Newark 3, N. J. Booth **53.**

Exhibiting: Temperature Controls for laboratories, industrial processes, furnaces and ovens (—100° to 1750°F.).

In attendance: H. S. Burling, Pres.

Burlington Instrument Co., 214½ N. 4th St., Burlington, Iowa. Booth **48.**

Exhibiting: A-c. and D-c. Electrical Indicating Instruments and Voltage Regulators.

In attendance: C. E. McGuigan, Sales Engr.; W. W. Corman, Ass't Sales Mgr.

Caldwell-Clements, Inc., 480 Lexington Ave., N. Y. 17, N. Y. Booth **139.**

Exhibiting: *Electronic Industries* Magazine display will feature editorial coverage of electronic instrumentation.

In attendance: Ralph R. Batcher, Consulting Ed.; Paul H. Hunter, Instrumentation Ed.; Ben Morris, Promotion Mgr.; D. J. O'Rourke, Cleveland Mgr.

Carson Micrometer Corp., 28 Edison Place, Newark 2, N. J. Booth **154.**

Exhibiting: Carson Electronic Micrometers, Models M, L, S, and W, for measurements to 0.00005" independent of operator skill.

In attendance: Robert W. Carson, Pres.; J. Ralph Edwards, Sales Mgr.

Consolidated Engineering Corp., 1255 E. Green St., Pasadena, Calif. Booth **55.**

Exhibiting: Type 4-102 Velocity Pickup, Type 1-110 Vibration Meter, Type 30-103 Electrical Computer, Type 5-101B Recording Oscillograph, Type 1-106 Amplifier, Type 8-103C Bridge, Type 3-115 Power Supply, Type 4-101 Accelerometer Pickup, Type 4-106H Velocity Pickup (horizontal), Type 4-106V Velocity Pickup (vertical), Type 4-111 Accelerometer, Type 9-101A Torsiograph, Type 7-100 Series Galvanometers.

In attendance: H. W. Ruby, C. E. Berry.

Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill. Booths **141-142.**

Exhibiting: Pressure Switches, Relays, Expansion Joints, High Temperature Engine Exhaust Bellows, Aircraft Controls and wire communication equipment.

In attendance: D. D. Foster, Mgr. Pgh. Dist. Off.; A. H. Stroyd, Application Engr. Pgh. Dist.; G. E. Doty, Application Engr. Pgh. Dist.

Commercial Research Labs., Inc., 20 Bartlett St., Detroit 3, Mich. Booth **17B.**

Exhibiting: Air Flow Meter, Industrial and Laboratory Fluid Flow Meters, Engine Indicator Equipment, Vibration Study Equipment, Electronic Equipment for Pressure and Vibration Studies and General Industrial Use.

In attendance: Hadley Smith, M. N. Weber, Sales Dept.

Communication Measurements Lab., 120 Greenwich St., N. Y. 6, N. Y. Booth **75.**

Exhibiting: Model 1210 Stroboscope, Model 1800 Frequency Meter, Model 1115 Power Supply, Model 1100 Power Supply; Model 1500 Megohm Meter.

In attendance: D. A. Griffin, Sales Mgr.; A. A. Devine, Sales Dept.

Control Equipment Co., 547 Brushton Ave., Pittsburgh 21, Pa. Booth **60.**

Exhibiting: Metalsorter.

In attendance: N. F. Agnew, W. P. Place, Ralph Scherger, Andy Kukel, John Spicer, S. G. Sciullo, A. Doschek, W. Weston, H. W. Newman (Representatives).

Davis Emergency Equipment Co., 45 Halleck St., Newark 4, N. J. Booth **175.**

Exhibiting: New Thermal Conductivity method of gas analysis; Combustible Gas Indicators and Alarms.

In attendance: F. R. Davis Jr., Ass't to Pres.; Geo. Bassinder, Sales Engr.

E. J. Deckman Co., Oliver Bldg., Pittsburgh, Pa. Booth **19.**

Exhibiting: Sarco Co. products.

In attendance: J. R. Allison.

Electric Glass Co., 249 N. 4th St., Philadelphia 6, Pa. Booth **23.**

Exhibiting: Adjustable Mercurial Thermostat, Bi-metallic Thermostat, Mercurial Thermostats and Thermometers.

In attendance: John F. McAllister, Owner; James McCrea, Jr., Sales Mgr.

Electro-Tech Equipment Co., 331 Canal St., N. Y., N. Y. Booth **149.**

Exhibiting: New Type Pyrometer with interchangeable thermocouples; Selenium Rectifier Packaged Unit, for use in small plating work, or as a d-c. power source in laboratories.

Equipoise Controls, Inc., 100 Stevens Ave., Mt. Vernon, N. Y. Booth **157.**

Exhibiting: Bimetal Dial Thermometers and Separable Sockets.

In attendance: Roy F. Coleman, Pres.; Earl E. Whitaker, Pgh. Rep.

Federal Products Corp., 1144 Eddy St., Providence 1, R. I. Booth **133.**

Exhibiting: Indicating Micrometer, Small Hole Gage; Federal-Metricator Air Gage, Federal—Foote, Pearson Electronic Gage; Perpendicular Universal Testmaster Indicator, small size regular type Dial Indicators with 1¼" diam.; bench type Thickness Gages, Electro-mechanical Gages for gaging by either signal lights or by sound; complete line of Dial Indicators and various Dial Indicator Gages.

In attendance: J. A. Bouslough, Pgh. Rep.; I. A. Hunt, Mgr. Sales Prom. & Adv. Dept.

Fisher Governor Co., Marshalltown, Iowa. Booths **106-107.**

Exhibiting: Diaphragm Motor Valves, Pressure Regulators, and Level Controllers.

In attendance: P. A. Elfers, V. P. and Sales Mgr.; L. E. Eige, Asst. Sales Mgr.; W. A. Stoeltzing, S. W. Prince, C. W. Milliken, Pittsburgh Reps.

Fischer and Porter Co., County Line Rd., Hatboro, Pa. Booths **150-151.**

Exhibiting: Rota-tronic electronic equipment for powering recorder and controller mechanism of recorder controller or totalizer accessories; Pneumatic Transmitter, for installations in hazardous locations; Continuous Viscosimeter; Ratio Controller, Rotameters, various special types, Rotasights and Rotasight Alarms, Glass Specialties and Glass Precision Bore Tubing.

In attendance: Wm. A. Diament, V. P.

John T. Fuhrman, Jr., 6936 McPherson Blvd., Pittsburgh, Pa. Booths **98, 99, 100.**

Exhibiting: Products of Autotron Co., Production Instrument Co., and Service Recorder Co.

In attendance: John T. Fuhrman, Jr.

R. P. Gallien, 220 W. 5th St., Los Angeles 13, Calif. Booth **20.**

Exhibiting: Wheel Cutters, Cleaning Machines, Flexible Shaft Machines, Motors; complete set watchmakers equipment, aircraft instrument repair tools and equipment.

In attendance: R. P. Gallien, owner; Sam Hetrick, Ass't.

General Electric Co., 1 River Rd., Schenectady 5, N. Y. Booths **144, 145, 146, 147, 148.**

Apparatus Dept.

Exhibiting: I. Instruments:1. CF-2 temperature recorder (inkless), 2. Autopot (self-balancing potentiometer), 3. CF-3 inkless tachometer recorder, 4. Vacuum tube voltmeter, 5. Hardness tester (magnetic), 6. Gauss meter, 7. Cushioning meter, 8. Radiation meter, 9. Photoelectric recorder, 10. Thermocouple vacuum gage, 11. Thermocouple potentiometer, 12. Small panel instruments, 13. Switchboard instruments, 14. Hook on volt ammeter, 15. Process time switches; II. Instrument Components & Accessories: 1. Thermocouple wire, 2. Radiation thermocouples, 3. Glass Jewels, 4. Light cells; III. Vacuum and Gas Analysis Equipment: 1. Ion gage, 2. Leak detector, 3. X-ray photometer, 4. Dewpoint recorder, 5. Mercury vapor detector; IV. Materials Test Equipment: 1. Magnetic Comparator, 2. Insulation resistance meter, 3. Zahn Viscosimeter, 4. Standard roughness specimens, 5. Sheet fault detector, 6. Fatigue machine—PRBS, 7. Luximeter; V. Gages: 1. Pipe thickness gage, 2. Thickness gage—Type B, 3. Magnetic Strain gage; VI. Time and Speed Equipment: 1. Time interval meter, 2. Electronic tachometer; VII. Miscellaneous Products: 1. Colorscope, 2. Opinion Meter, 3. Sound level meter, 4. Liquid level controller.

In attendance: W. C. Hutchins, Mgr. Spec. Prod. Div., Schenectady, Nelson Gudersleeve, C. W. Bowman, G. A. Doxey, L. A. Mooney, R. R. Person and H. Johnston, Spec. Prod. Div.; C. A. Hansen, Jr. and H. T. McLean, Gen Eng. and Consulting Lab., Schenectady; H. D. Middel, Ind. Engrg. Dept., Schenectady; C. W. Downs, Visual Education Div., Schenectady; H. S. Day, N. S. Stone, R. J. Hoffman, Meter and Inst. Div., West Lynn, Mass.

Electronics Dept.

Exhibiting: Industrial Tube Checker—TT-1; Regulated Power Supplies PS-1, 2, 5; Square-Wave Generator; Electronic Switch—YE-9; Audio Frequency Meter—YE-5; Wavemeter—WM-4; Electric Volt Ohm Meter—PM-17; Oscilloscope—CRO-5A; Resistance Capacitance Bridge—YCW-1; Complete line of Quartz Crystals.

In attendance: R. D. Payne, Mgr. of Sales, Spec. Div.; R. H. Rudolph, Sales Mgr. Prec. Equip. Spec. Div.; N. E. Schick, Engr., Spec. Div.; R. E. Cassatt, Sales Prom. and Advt. Mgr., Spec. Div.

Gotham Instrument Co., 149 Wooster St., New York 12, N. Y. Booth **90.**

Exhibiting: Air-operated Controllers with special air relay; "Ministrane" etched stem thermometers; pressure and vacuum gages; dial, industrial and recording thermometers and controllers.

In attendance: Walter J. Halpern, Pres.; Robt. Hamerschlag, V. P. in charge of Sales; Wm. Boder, Pgh. Rep.

Hammel-Dahl Co., 243 Richmond St., Providence 3, R. I. Booths **176-177.**

Exhibiting: 3" Stainless Steel Split-flange Diaphragm Control Valve; 1" Bellows-sealed Air-cooled Bonnet Diaphragm Control Valve; ¾" Straight-through Bar Stock Body Diaphragm Control Valve; 2" Pressure Balanced Diaphragm Control Valve; ¾" Angle Bar Stock Body Diaphragm Control Valve; 6" Steel Body Air-cooled Bonnet Diaphragm Control Valve; Recirculating Valve; Miscellaneous plugs and seat rings.

In attendance: E. T. Dahl, Part.; B. G. Woolley, Part.; B. Irwin, Sales Mgr.; A. Koch, Ass't Sales Mgr.; O. Kneisal, Dev. Eng.; J. Curran, Des. Eng.; D. Golner, Dev. Eng.; W. B. Farley, Dist Sales Mgr.; H. Miller, Dist. Sales Mgr.; G. Dahl, Des. Eng.

Harris Pump and Supply Co., Brady and Sidney Sts., Pittsburgh 3, Pa. Booths **68-69.**

Exhibiting: Geo. Scherr Co., Inc. Micrometers and Gages; L. S. Starrett Co. Precision Tools; Lufkin Rule Co. Precision Tools.

In attendance: F. W. Robertson, Mgr. Mach. Div.; H. L. Jones, Mach. Div.; A. L. McQuillen, Mach. Div.; P. J. Marzano, Mach. Div.; M. A. Kelly, Mgr. Tool Div.; J. E. Hindes, Tool Div.; J. Hindes, L. S. Starrett Co.; W. F. Rockwell, Lufkin Rule Co.

Helicoid' Gage Div., American Chain & Cable Co., Bridgeport 2, Conn. Booth **165.**

Exhibiting: Helicoid Pressure Gage, made with Helicoid movement, and a giant Helicoid movement; Gages.

In attendance: W. A. Stoeltzing, Dist. Rep.; J. V. Tracy, Sales Mgr.

Illinois Testing Laboratories, Inc., 420 N. LaSalle St., Chicago 10, Ill. Booths **46-47.**

Exhibiting: Dew Point Indicator for rapid determination of dew point, relative humidity, grains moisture per lb., and latent heat of any non-corrosive gas; Alnor velometers and pyrometers.

In attendance: M. J. Rauscher, Sales Mgr.

INSTRUMENTS PUBLISHING CO., INC., 1117 Wolfendale St., Pittsburgh 12, Pa. Booth **14.**

Exhibiting: *Instruments* the Magazine of Measurement and Control, *The Instrument Maker*—the Trade Journal of the industry; "Maintenance and Servicing of Electrical Instruments" by Spencer, "Elementary Engineering Electronics" by Kramer, "Mechanical Measurements by Electrical Methods" by Roberts, published by Instruments Publishing Co. Also displayed is a library of books and other publications devoted to the overall field of instrument technology.

In attendance: Richard Rimbach, Managing Editor; M. F. Behar, Editor; John MacQuilken, Associate Editor; M. F. Lovejoy, Assistant Editor; James Condon, Boston Rep.; C. Goldcamp, Pittsburgh Rep.; R. K. Farnham, New York Rep.; Harold W. Haskett, Chicago Rep.; Stuart Rogers, Philadelphia Rep.

J-B-T Instruments Inc., 441 Chapel St., New Haven 8, Conn. Booth **101.**

Exhibiting: Appliance Temperature Tester, Model 60-JRT; Oven Temperature Tester, Model 32-JP-1 & 32-JP-2; Vibrating Reed Frequency Meters; Vacuum-Tube Frequency Meters; Pyrometers; Temperature Testers; Tachometers; Electrical Indicating Instruments such as Voltmeters and Ammeters A-c. and D-c.

In attendance: Phillips Stevens, Sales Mgr.; Emil Nyitray, Ser. Engr.; M. M. Massey, Sales Rep.

Connecticut Telephone & Electric Div., Great American Industries, Inc., Meriden, Conn. Booth **50.**

Exhibiting: Keinath Multiple Stress-Strain Recorder; Rotary Stylus Sweep Balance Recorder.

In attendance: F. B. Powers, Vice Pres.; R. D. McGranahan, Factory Manager; R. K. Hellmann, Asst. Chief Engnr.

M. S. Jacobs Associates Inc., 807 Bessemer Bldg., Pittsburgh 22, Pa. Booths **160-161.**

Exhibiting: W. C. Dillon & Co. Dial Type Thermometers and other instruments; Continental Equipment Co. Butterfly Valves; Barton Instrument Co. Differential Pressure Gages.

In attendance: Mifflin S. Jacobs, Walter F. Gieryk.

Kiely and Mueller, Inc., 2013-33 43rd St., North Bergen, N. J. Booth **158.**

Exhibiting: Diaphragm Motor Control Valves, Pressure Reducing Valves, and Back Pressure Regulators, using new "Kontrol Motor" steel diaphragm construction; complete line of valve bodies in brass, iron, steel and special alloys; liquid level float gages; traps and strainers.

In attendance: Clifford B. Ives, Chief Engr.; Robert J. Donnelly, Sales Engr.; Ward K. Stallings, Sales Engr.; John D. Hiles, Dist. Rep.

Leslie Co., Lyndhurst, N. J. Booths **58-59.**

Exhibiting: Leslie single seated fully balanced diaphragm operating valve; Reverse acting superstructure for diaphragm regulating valve; Pump Governors; Temperature Regulators; Pressure Controllers; Strainers, Leslie-Tyfon Whistles.

In attendance: H. G. Jones, Bernard Bremer, Harold G. Jones Co., Pgh., Pa.

Linde Air Products Co., 30 E. 42nd St., New York 17, N. Y. Booth **70.**

Exhibiting: Flame shaping and Flame polishing of synthetic sapphire rods pictorially; synthetic white sapphire boule and rod; synthetic ruby boule and rod; synthetic blue spinel boule and rod.

In attendance: A. K. Seemann, J. J. Hock Jr., W. S. Winn, W. G. Myers, L. S. Macon, D. E. Tatom, H. P. Vaughan Jr., J. M. Roeser, J. N. Roche, J. H. Patterson, R. L. Kester.

Linotone Corp., 563 W. 35th St., New York 1, N. Y. Booth **135.**

Exhibiting: Linotone processed dials scales and indices.

In attendance: Arthur P. Paine, Pres.; Hugh F. Gage, Sales Engr.; F. G. Braham, Gen. Mgr.; Joseph P. Vitrano, Sales Engr.; Ransom H. Turner, Chief Engr.

Bernard S. Lippman & Co., 630 5th Ave., New York, N. Y. Booth **140.**

Exhibiting: Imported Watches, Stop Watches and Timers for Industry; Rapid Computers, Chronographs, Nautical Timers, Production Timers.

In attendance: Arnold M. Cassin.

Macbeth Corp., 227 W. 17th St., New York 11, N. Y. Booth **12.**

Exhibiting: Macbeth line-operated pH meter, direct reading and continuously indicating; color matching equipment.

In attendance: Norman Macbeth, F. G. Paully.

Madison Electrical Products Corp., 78 Main St., Madison, N. J. Booths **78-79.**

Exhibiting: Resistors—precision wirewound, hermetically sealed; Transformers—I.F., coils—antenna, oscillator; R. F. Trimmers; chokes; F. M.; Filament.

In attendance: John G. Ruckelshaus, Pres.; Charles A. Remlinger, Sales Mgr.

Mason-Neilan Regulator Co., 1190 Adams St., Boston 24, Mass. Booths **25-26.**

Exhibiting: Displacement Type Liquid Level Controllers: Model 12,610 Proportional-Reset Controller, Model 12,600-20 Controller and Pneumatic Transmitter; Control Valves: Model 107 and 108 Control Valves, Model 37 and 38 Percentage Piston Control Valve; Model 485-1 Explosion Proof Pneumatic Sequential Signal Switch; Percentage Piston Control Valve, Percentage V-port Control Valve, Signal Lights for No. 485-1, Model 93-D Level Controller Pilot, Model 50,007 Instrument Pilot; Regulators: Model 11 Pilot Operated Steam Reducing Valve, Model 27 Pilot Operated Reducing Regulator, Model 33 Reducing Valve, Model 39 Differential Pressure Regulator, Model 227 Water Reducing Valve, Models 509 & 515 Reducing Valves, Strainer.

In attendance: E. A. Bianchi, Asst. Sales Mgr.; R. A. Rockwell, Dir. of Engr.; F. K. Morrison, V.-P. in Chg. Sales; A. B. Powell, Pgh. Brn. Mgr.; R. Benson, Cleveland Brn. Mgr.; P. Head, Buffalo Brn. Mgr.; J. W. Brown, Sales Engr.

Meriam Instrument Co., 10920 Madison Ave., Cleveland 2, Ohio. Booth **96.**

Exhibiting: Dual-Tube Manometer, Micromanometer, Manometers, draft gages, pressure gages, altimeter test unit, air speed test unit.

In attendance: A. A. Hejduk, V.P.; O. W. Heyman, Sales Egnr.; Mark Meriam, Secy.

Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh 8, Pa. Booths **66-67.**

Exhibiting: M.S.A. Oxygen Indicator, Type "C"; M.S.A. Photoelectric Vapor and Gas Analyzer; Carbon Monoxide Indicators and Alarms, Combustible Gas Indicators, Alarms and Recorders, Hydrogen Sulphide Detector, Electrostatic Dust & Fume Sampler, Midget Impinger, Gas Masks, Respirators, Skullgards, Inhalator, First Aid Materials, Safety Clothing, Goggles, etc.

In attendance: J. B. Davies, Mgr. Indust. Dept.; N. W. Hartz, Indust. Sales; J. Gray, H. Snyder, H. R. Clinton.

Moore Products Co., 901 E. Lycoming St., Philadelphia 24, Pa. Booth **52.**

Exhibiting: Industrial Instruments.

National Research Corp., 100 Brookline Ave., Boston 15, Mass. Booth **73.**

Exhibiting: Vacuum measuring equipment; Vacuum Pumps, Gages and protective devices.

In attendance: E. C. Bowen, Sales Mgr., C. W. Carr, Sales Engr.; J. B. Merrill, Jr., Sales Engr.

Naval Ordnance Laboratory, U. S. Naval Gun Factory, Washington 25, D. C. Booth **143.**

Exhibiting: A Magnetic Mine Firing Mechanism and other Ordnance Equipment.

In attendance: G. L. Beyer, Jr., E. L. Deeter, H. T. Gittings, J. M. Norton, M. J. Relis.

Paragon Electric Co., 37 W. Van Buren St., Chicago 5, Ill. Booth **49.**

Exhibiting: Timers.

In attendance: E. V. Platt, Pres.

Henry Paulson & Co., 37 S. Wabash Ave., Chicago 3, Ill. Booth **24.**

Exhibiting: Watch Timer, Spot Welder for precision soldering.

In attendance: Harry Egerter.

Permo, Inc., 6415 Ravenswood Ave., Chicago 26, Ill. Booth **138.**

Exhibiting: Permopivots.

In attendance: E. C. Steffens, V.P. & Gen. Mgr.; Sherman E. Pate, Mgr. Permopivot Div.

Physicists Research Co., 321 S. Main St., Ann Arbor, Mich. Booth **62.**

Exhibiting: Bearing Race Tester; Profilometer.

In attendance: J. M. Trytten, Sales Mgr.; Fred J. Engelke, Wayne G. Klager, F. W. Kabat, Field Reps.

Pittsburgh Equitable Meter Div., Rockwell Mfg. Co., 400 No. Lexington Ave., Pittsburgh 8, Pa. Booth **15.**

Exhibiting: Gas Meters, Regulators and Gages, Gasoline and Oil Meters, Valves.

In attendance: J. J. Gavin, L. M. Oakes, J. R. Sproat, W. S. Andrews.

Pomeroy Stereograph Co., Inc., 1783 E. 11th St., Cleveland 14, Ohio. Booth **22.**

Exhibiting: Third Dimension Perspective Drawing Machines.

In attendance: Jos. Hirshstein, Pres.; Leo N. Newman, Sec'y; Harold Heuser, Sales.

Precision Thermometer & Instrument Co., 1437 Brandywine St., Philadelphia 30, Pa. Booth **162.**

Exhibiting: Industrial and Laboratory Thermometers, Barometers, Absolute Pressure Gages, Hydrometers, Vacuum Gages, Manometers, Thermostats, Relays, Hygrometers.

Precision Tube Co., 3828 Terrace St., Philadelphia 28, Pa. Booth **168.**

Exhibiting: Precision Metal Shielded Wire, Seamless Non-Ferrous Tubing, Instrument Pointer Tubing, Capillary Tubing, Air Restriction Tubing.

In attendance: Norman H. Jack, Jr. Pro. Mgr.; Charles F. Flachbarth, Chf. Engr.

Process Control Co., Inc., 2 E. End Ave., New York 21, N. Y. Booth **21.**

Exhibiting: Time Cycle Controllers, Servomechanisms.

In attendance: Dr. A. C. Hall, Dir.; Kirby B. Austin, Mgng. Engr.; John M. Manypenny, Comm. Mgr.

Production Instrument Co., 710 W. Jackson Blvd., Chicago 6, Ill. Booth **99.**

Exhibiting: Mechanical & Electrical Counters & Accessories, Predetermined Electric Counters, Actuating Switches, Time Totalizers.

In attendance: John T. Fuhrman, Jr., Pgh. Rep.; R. E. Harvey, Chicago Sales.

Pyrometer Instrument Co., 103 Lafayette St., New York 13, N. Y. Booth **164.**

Exhibiting: Immersion Pyrometers, Optical Pyrometers, Radiation Pyrometers, Indicating Pyrometers, All-purpose Pyrometer.

In attendance: A. Bollerman, P.V. Bollerman, Earl Whitaker.

R. B. M. Div., Essex Wire Corp., Logansport, Ind. Booth **77.**

Exhibiting: Midget Single and Multiple Pole Magnetic Relays, Low Voltage Control Accessories, Magnetic Contactors, Voltage Regulators, Industrial Type Magnetic Relays, and Multiple Relays.

In attendance: H. L. Huntsinger, Sales Mgr.; H. F. Barnes, Sales Engr.; P. C. Talmadge, Design Engr.

Rack Engineering Co., 5102 Butler St., Pittsburgh 1, Pa. Booths **171-2-3-4.**

Exhibiting: Hydraulic Die Tables, Hydraulic Press Feed Tables, Material Storage Racks and Rack Conveyors.

In attendance: S. Saul, Jr., Chf. Engr.; David Gold, Div. Engr.; Harold W. Wiese; Paul R. Minich, Div. Engr.; M. A. Travis, Div. Engr.

Refinery Supply Co., 621 E. 4th St., Tulsa, Okla. Booth **108.**

Exhibiting: Smoke Meter, Senior Midget Industrial Thermometers, Ac-Me Recording Gravitometer, Gas gravity balance.

In attendance: W. A. Schlueter, Pres.; A. W. Chandler, Chf. Engr. in Chg. of Prod.; H. F. Goodenough, Chf. Engr. of Res.

Revere Corp. of America, 322 N. Cherry St., Wallingford, Conn. Booth **131.**

Exhibiting: Flight Testing Instruments, including those for Jet Aircraft, Thermocouples and accessories.

In attendance: Thomas Ball, Jr., Gen. Mgr.; J. L. McCoy, Sales Engr.; W. A. Dommers, Sales Engr.

Ring Balance Instrument Co., 740 W. Franklin St., Chicago 10, Ill. Booth **95.**

Exhibiting: Spring-loaded Meter, Mechanical Flow Meters, Differential Pressure Recorders, Specific Gravity Recorders.

In attendance: Otto B. Vetter, Pres.; Sprague A. MacKenzie, Engr.; Otto J. Lessa, Engr.; Harold A. Woolman, Sales Rep.

R-S Products Corp., Wayne Junction, Philadelphia 44, Pa. Booth **137.**

Exhibiting: Butterfly Valves and equipment.

In attendance: Daniel Hopkins.

W. C. Robinette Co., 802 Fair Oaks Ave., So. Pasadena, Calif. Booth **109.**

Exhibiting: Motron electronic package Servomechanism.

In attendance: W. C. Robinette, Part.; Kendal Clark, Sales Rep.

Rowe Radio Research Laboratory Co., 2422 N. Pulaski Rd., Chicago 39, Ill. Booths **86-87.**

Exhibiting: Rowe Tel-O-Buz, Electronic Spark Plug Tester, Watchmans Protector, Radioactivity "R" Meter, Electronic Steel Hardness Comparator, Synchro Cyclic Timer, Precision Pulse Generator, Elapsed Milli-seconds Meter, Angular Sweep Potentiometer.

In attendance: Harry C. Rowe, Pres.; D. V. Sinninger, S. C. Kohl, M. Tanenbaum, R. Parisoe, C. Donaldson, J. M. Lomasney, W. J. DuHart.

Milton Roy Co., 1300 E. Mermaid Ave., Philadelphia 18, Pa. Booth **91.**

Exhibiting: Automatic Chemical Feed Systems, Controlled Volume Metering Pumps.

In attendance: G. C. Moore, Dist. Engr.; R. T. Sheen, Exc. V.P.; Paul C. Flucke, Chem. Engr.

Rubicon Co., Ridge Ave., at 35th St., Philadelphia 32, Pa. Booth **82.**

Exhibiting: Photoelectric Galvanometer, Hercules General Purpose Photometer, Precision Potentiometers, High Precision & Portable Wheatstone Bridges, Kelvin Bridge, Resistance Standards, Evelyn Photoelectric Colorimeter.

In attendance: Philip M. Andress, Carl Boyer, Jr.

Sarco Co., Inc., 475 5th Ave., New York 17, N. Y. Booth **18.**

Exhibiting: Electric Temperature Process Controls, Self-contained and Remote Indicating and Recording Controllers, Hydraulically Operated Valves, Steam Traps, Self-operated Temperature Regulators, Hot and Cold Water Mixing Valves, Steam and Water Mixers.

In attendance: J. H. Allison, E. J. Deckman Co., Pgh. Rep.

Schutte & Koerting Co., 12th & Thompson St., Philadelphia 22, Pa. Booth **63.**

Exhibiting: Free float type, Gas, Orifice & Nozzle Flowmeters.

In attendance: H. W. Gripton, Mgr. Meter Dept.; A. C. Elsasser, Eng.; S. G. Ketterer, Chem. Engr.

Service Recorder Co., 1375 Euclid Ave., Cleveland 15, Ohio. Booth **100.**

Exhibiting: Running Time Recorder.

In attendance: John T. Fuhrman.

Size Control Co., Div. American Machine & Gage Co., 2500 W. Washington Blvd., Chicago 12, Ill. Booth **167.**

Exhibiting: Centerless Lapping Machine, Reversible "Go and No-go" Plug & Thread Gages, Ring Gages, Snap Gages, AGD Plug & Thread Gages, Measuring Wires, Gage Blanks.

In attendance: Wallace Carroll, Pres.

Sola Electric Co., 2525 Clybourn Ave., Chicago 14, Ill. Booth **136.**

Exhibiting: Constant-voltage Transformers; low capacity voltage-regulating transformers for instrument applications.

In attendance: C. H. Humes, Sales Engr.; Frank Burke, Sales Rep.

Specialty Screw Machine Products Co., Dillerville Rd., Lancaster, Pa. Booth **153.**

Exhibiting: Precision Screw Machine products, from Swiss type automatics.

In attendance: A. V. Orsi, N. Y. & N. J. Rep.; Reece Geissinger, Pittsburgh Rep.

Standard Electric Time Co., 89 Logan St., Springfield 2, Mass. Booth **163.**

Exhibiting: High-speed Counter, Precision Timers, Jacks and Plugs, Chrono-tachometers, Binding Posts, Custom Built Panel Work.

In attendance: L. K. Porter, Sales Engr.; F. J. Foley, Sales Engr.; E. S. White, Ass't Sales Mgr.

Statham Laboratories, 8222 Beverly Blvd., Los Angeles 36, Calif. Booth **156.**

Exhibiting: Strain Gage Bridge, Pressure Transmitter, Accelerometers, Statham Gage.

W. A. Stoeltzing, 1222 Empire Bldg., Pittsburgh 22, Pa. Booths **106-107.**

Exhibiting: Products of Fisher Governor Co., Palmer Thermometer Co., Permutit Co., Farris Engineering Co.

In attendance: W. A. Stoeltzing.

Superior Electric Co., 83 Laurel St., Bristol, Conn. Booth **13.**

Exhibiting: Powerstat Variable Transformer, Seco Automatic Voltage Regulators, Voltbox A-c. power supplies.

In attendance: A. B. Nelson, J. S. Louden, W. Anderson, E. K. Becker, W. P. Carpenter, T. L. Hannon.

Surty Mfg. Co., Inc., 4139 W. Kinzie St., Chicago 24, Ill.

Exhibiting: Optical Magnifiers of various types.

Televiso Products Co., 7466 W. Irving Park Rd., Chicago 34, Ill. Booths **56-57.**

Exhibiting: Series 200-A Vacuum Tube Voltmeter, Model J Audio Signal Synchroniser, MR-1000 Audio Frequency Generator, Model 11-B Vibrometer, Model U-500 Ultrason, Model U-300 Ultrason.

In attendance: H. D. Von Jenef, Chf. Engr.; Jay B. Atkinson, Prod. Mgr.; F. L. Bunn, Sales Mgr.

Trimount Instrument Co., 37 W. Van Buren St., Chicago 5, Ill. Booth **159.**

Exhibiting: Pressure Transmitter and Indicating Receiver; Tank Level Gages; Electronic Level Controls; Cathodic Protection for Corrosion Prevention.

In attendance: J. L. Mayer, Pres.; Gene Kreml, Sec'y; Alex Weiss, Phil Jaynes, Ed. Knowwing, J. G. Cotter, Ben Baru, Sales.

Triplett Electrical Instrument Co., Bluffton, Ohio. Booths **84-85.**

Exhibiting: Electrical Indicating Instruments: Voltmeters, Decibel Meters, Millivoltmeters, Microammeters, Ammeters, Instrument Relays, Electrodynamometer instruments, Milliammeters, RF Ammeters, Thermocouple type instruments, Volume unit meters, Rectifier type instruments, Volume indicators, Wattmeter, Magnetometers, Megohm voltmeters; Testers: Tube testers, Signal generators, Transconductance tube testers, Volt-ohm-milliammeters, Vibrator testers, Modulation Monitors, Continuity testers, Voltage testers, Electronic voltmeters, Appliance testers, Ohmmeters, Output indicators.

In attendance: N. A. Triplett, C. J. Sheridan, F. J. Lingel, A. R. Baker.

Victoreen Instrument Co., 5806 Hough Ave., Cleveland Ohio. Booth **70.**

Exhibiting: Scaler, Radioactivity Indicator, Geiger Tubes, Electronometer, Protexi-meter, Beta Radiation Meter, Sampler Pig, Water Sampler Pig.

In attendance: A. E. Heiser, Div. Sales Mgr.; Art Bush, Design Engr.; R. Barton, Physicist; W. Shafer, Electronic Engr.; D. L. Collins, Lab. Div.

Waldes-Kohinoor, Inc., 47-10 Austel Place, Long Island City 1, N. Y. Booths **169-170.**

Exhibiting: Truarc Retaining Rings and Pliers.

In attendance: Joseph Bloom, Adv. Mgr.; John E. Fasano, Sales Mgr.; Max Vander Veen, Sales Rep.; Harry Waldes, Ass't to Pres.; Jules Brell, Design Engr.

Wallace & Tiernan Products, Inc., 1 Main St., Belleville 9, N. J. Booth **74.**

Exhibiting: Precision Aneroid Barometers, Barometers, Manometers, Gages, Manostats, Torsional Relays, Constant Speed D-c. Motors.

In attendance: Warren F. Haring, Mgr. Inst. Sales; Lester E. Demler, Sales Engr.

Waltham Precision Tool Co., Waltham, 54, Mass. Booth **166.**

Exhibiting: Contact Points, Anvils, and accessories for Dial Indicators and Gages, Diamond and Sapphire wear-resisting specialties, Norbide and Tungsten Carbide, Extrusion Dies.

In attendance: Wilfred B. Wells, V.P.

Waterman Products Co., Inc., 2445-63 Emerald St., Philadelphia 25, Pa. Booth **51.**

Exhibiting: Pocketscope-Oscilloscope.

In attendance: William Waterman, Pres.; Lester Lappin, Engr.; Alden Leiby, Engr.; Morris Cooper, Sales Mgr.

Webber Gage Co., 12900 Triskett Rd., Cleveland 11, Ohio. Booth **155.**

Exhibiting: Precision Angle Gage Blocks, Precision Carbide Blocks, Rectangular Precision Gage Blocks, Heavy Duty Precision Gage Blocks.

In attendance; Geo. D. Webber, Partner.

W. M Welch Mfg. Co., 1515 Sedgwick St., Chicago 10, Ill. Booth **152.**

Exhibiting: Duo-Seal Vacuum Pumps, Electrical Meters, Balances, Stirrers, Timers, Atomic Weight Chart.

In attendance: John Gutsmiedl.

Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J. Booth **134.**

Exhibiting: Maximum-minimum type bimetal industrial testing thermometer, Insulation tester, Electronic volt-ohm-milliammeter, Light measuring instruments, Portable and panel instruments — voltmeters, ammeters, milliammeters, microammeters, wattmeters, photronic and relay equipment, temperature indicating equipment.

In attendance: Lawrence F. Parachini, Sales Dept.; Russell F. Clark, Pgh. Rep.; J. F. Rhodes, Sales; C. W. Carr, Sales.

Raymond M. Wilmotte Inc., 236 W. 55th St., New York 19, N. Y. Booth **65.**

Exhibiting: Visi-Limit Electronic Micrometer, Visi-Limit Curve Tracer.

In attendance: A. E. Keleher, Application Engr.; A. L. Short, Application Engr.

Winslow Co., 9 Liberty St., Newark 5, N. J. Booth **83.**

Exhibiting: Portable Galvanometers, Multi-Range Megohm Meters, Bridges, Resistance Boxes, High Vacuum Gages, Ignition Harness Test Set, Aircraft Engine Temperature Indicators and Components.

In attendance: Thomas P. Winslow, Pres.; Robert C. Wade, Sales Mgr.; William Osborne, Prod. Mgr.

John Worley Jewel Co., 19 Lane St., Waltham 54, Mass. Booth **166.**

Exhibiting: Flame-formed Thread Guides, Jewel Bearings, Sapphire Nozzles, Wear Parts of Sapphire.

In attendance: D. E. Worley, Pres.

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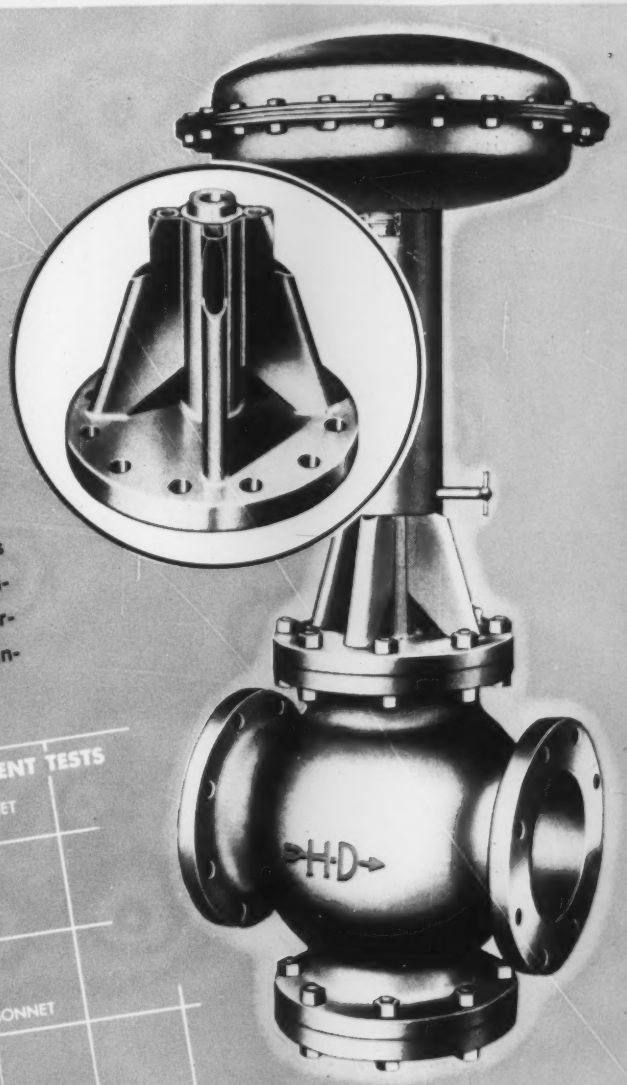

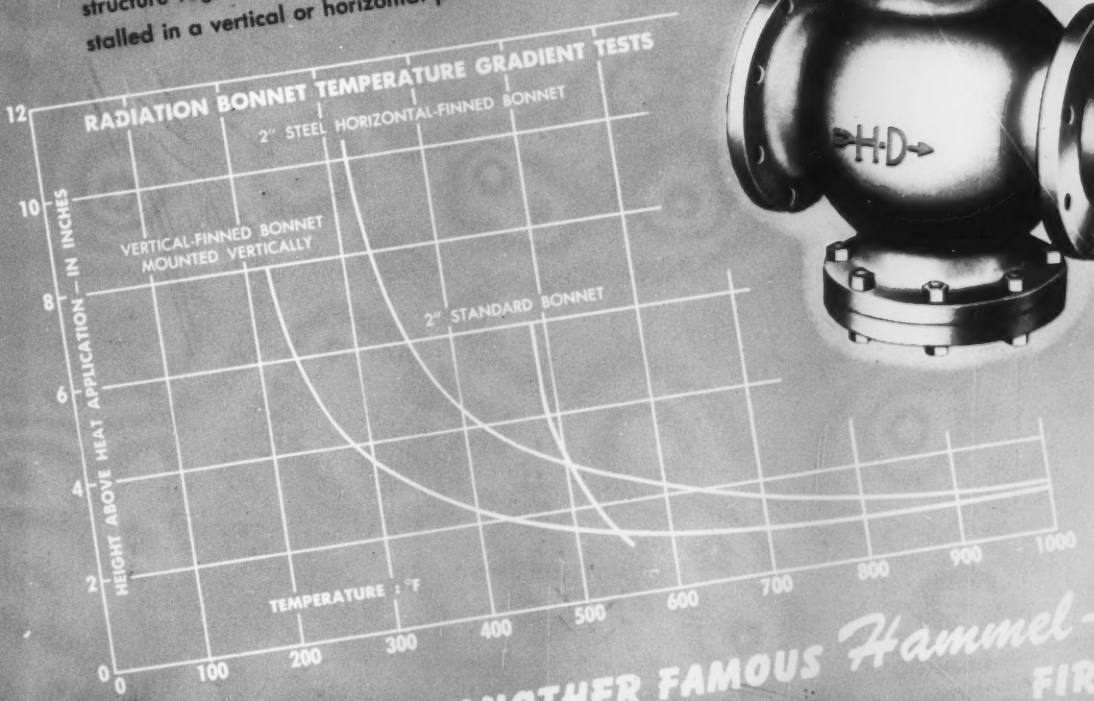

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